Published December 12, 1919, With Current News

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. McGRAW, *President*

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Volume 83 — NEW YORK, NOVEMBER 13–NOVEMBER 20, 1919 — Number 19

Dangers Besetting the Highway Program

ONE cannot expect in these crowded days to devote a large amount of time to topics outside his particular specialty. All engineers and contractors, however, are accustomed to give some attention to those features which for the moment occupy the centre of the constructional stage. At the minute highways form the central figure in the engineering drama. They have come into the lime-light suddenly, and are nearly forcing all other specialties into a dim background. But not for that reason alone does highway work merit general attention from engineers and contractors. They have a citizen's interest in it, as well as that of professional and business men. The situation is a serious one. Let those who have not followed highway work closely read the story in the presidential address of A. R. Hirst before the American Association of State Highway Officials, printed elsewhere in this issue. With appropriations for construction of $600,000,000 as against a previous maximum of $200,000,,000 ($150,000,000 would likely be near right) we find ourselves with totally inadequate organizations. How serious that is we learned from the inefficiencies of the war. From it may lead a chain of consequences that may bring a serious revulsion against highway expansion. One noted highway engineer expressed the feeling recently by saying that "we have gone highway mad." Millions are appropriated where there were but thousands before—which would not be serious if we had adequate organizations to handle the work. All of which is sound reason why engineers and contractors as citizens, as well as professional and business men, should support the pleas of highway engineers for organizations adequate in size and compensated at a rate that will insure the securing and retention of men of high ability. The penalty for failure to secure adequate organizations is the inefficient expenditure of the huge sums available and the checking of the progress toward building an adequate highway system.

Marking an Epoch

THOSE who recall the eventful March days of 1913, when the waters came down on the great Central States basin and wrought devastation throughout cities and countryside, should experience a distinct feeling of satisfaction at learning of the first definitely achieved curbing of one of the torrent-channels responsible for the great destruction. In October just past, the valley of Twin Creek, near Dayton, Ohio, was finally closed by the growing earth embankment of the Germantown dam; and soon afterward energetic work had brought the closure up to a height that assured its permanence and the protection of the lands downstream against even a large flood. This comes after six years of work: five of study and planning, and one year of construction. The present result is the first actual flood-protection secured, and thus it ranks as marking an epoch. Henceforth, each further step in the execution of the Miami Valley enterprise, of which Germantown forms a part, will bring increase of protection.

Dam Closure Risks

THE remaining valley closures of the Miami project are larger in size than that at Germantown, but they will be less difficult and formidable. All of them involve flood risks of decidedly unusual character, the result of building a dam in the lower rather than in the upper part of a valley. At Germantown especially the flood-flow possibilities were serious, and the resulting necessity of building up the hydraulic-fill core as fast as possible involved unknown difficulties. Only the short autumn season was available for the closure, to be followed by several months of high-water probabilities. Any hitch or delay would create risk of overtopping. The stream-control problem, which was recognized as a serious one from the earliest period of planning, and which governed the succession of working steps, has now been mastered in the case of Twin Creek. From the standpoint of engineering calculation, of course, it should be understood that the maximum degree of security will not be attained for some time to come, indeed not until the dam has been raised to crest elevation. A measure of risk from abnormal rainfall and flow conditions must inevitably exist through the coming high-water months, therefore. But within the range of human foresight the primary difficulties and dangers of the Germantown dam work have been disposed of. One of the most important means of assuring safety in the closure work is a new and excellent system of studying the physical character of the dam structure. But this is another story.

The Lugless Standard for Paving Brick

AT THE New Orleans convention of the American Society for Municipal Improvements the National Paving Brick Manufacturers Association made the first public announcement of the adoption of a lugless brick as its standard. The specification actually calls for a wire-cut brick with square edges, but the explanatory matter calls the new standard a "plain wire-cut, square-edged brick." The size is to be reduced from 3½ x 4 x 8½ in. to 3 x 4 x 8½ in. The reasons assigned for the changes are manufacturing ones—the economies resulting from reducing the number of styles of brick and from increasing the No. 1 output of the kilns. The bearing of these economies on cost of finished pavements is pointed out.

We do not anticipate that there will be much objection from engineers to the reduction in the size of brick, but we do expect a very wide disagreement regarding the adoption of a lugless standard for use with all types of filler. The manufacturers have been party to the creation of a standard brick with lugs, and they cannot turn their backs on the practice of the past without giving sound technical reasons. We believe that they made a tactical error at New Orleans when they supported the new standard on commercial grounds, even though an attempt was made to translate these commercial swings into terms of economy in the finished pavement. The primary responsibility of the engineer is to secure good work, and though the manufacturers sponsoring the new lugless standard claim that they can make a thoroughly sound engineering case, they failed to present the facts at New Orleans. We, ourselves, have seen excellent old-time pavements built of lugless brick, but we are not prepared, without full study to say that the lugless evidence available is sufficient to counterbalance all that we have done in recent years with the lug type.

We know, too, from the expressions of opinion received from a dozen engineers of big cities that the new specification is not going to be accepted until there is a clear engineering demonstration of the superior advantages of the new standard. Some of the officials of the National Paving Brick Manufacturers Association appreciate the need for this enginering presentation of the case and promise that it will be made. Until then, however, the new standard is nothing more than a target to shoot at and an invitation to those with experience to present their case.

Model Registration Laws

UNITY on the license question by engineers and architects is essential if headway is to be made without friction. The problem of drafting a model law is being attacked by several states and national organizations. Until now they have worked separately but it is high time that there be coöperation.

Recently the American Institute of Architects wrote a model registration law for architects, and at the last annual meeting chapters were urged to work for its enactment, and the inclusion of its features in revisions of existing laws. Engineering Council's committee has practically completed its draft of a model law for professional engineers, architects and land surveyors. The architects do not believe in such a combination law. Their objection, that a board might be made up of a majority of engineers or of architects is answered in the engineer's law by the requirement for a minimum number of each on the board and a majority of each to pass on applicants in their respective professions.

The architects define the practice of architecture as the planning or supervision of the erection, enlargement or alteration of any building or any appurtenance thereto. Buildings are defined as structures consisting of foundation, floors, walls, columns, girders and roof, or a combination of any number of these parts, with or without other parts or appurtenances. A foot-note states that it is unwise and unnecessary to define these terms. The engineers left them out Rigid examinations are prescribed by the architects, whereas only evidence of qualifications, submitted under oath, is required by the engineers.

The following significant statement is made by the architects in connection with their model law: "There are many structures which an engineer can properly care for without the assistance of an architect, and there are many cases of small structures, drawings for which can be made by the contractor. We should rely on this attitude to enable us to coöperate on a friendly basis with the engineering profession and with contractors, who will ultimately concede the moral right of the architect to take care of all work within his province provided the architect maintains high standards of qualifications. Great importance is attached to this view of the matter, inasmuch as it is based on the unsatisfactory experience of the profession in two or more of the states." The engineers cover this point by letting registered engineers practice architecture or registered architects practice engineering on the supposition that a professional man of the high standards required will call in competent help if the problem requires it. Other differences exist, but certainly the engineer's combination bill is the more likely to create a feeling of friendliness and so present a united professional front to the laymen. An agreement should be reached before either bill is actively promulgated. That there is need for a model bill requires little argument, for engineers now have restricting legislation in ten states and architects in seventeen.

The Development Committee's Report

ABOUT two weeks ago the American Society of Civil Engineers placed in the hands of its members the long-awaited report of the Committee on Development. The document, while formally a report to the Board of Direction, is placed in the hands of the members for their study and criticism. Presumably, it will be one of the subjects for discussion at the annual meeting in January. The report falls naturally into two sections, that relating to the affairs and management of the society itself, and that covering coöperation with other bodies through the medium of a general federation. The first part follows in the main the recommendations made in the preliminary report last June, and published in full in this journal, while the second portion was abstracted on p. 835 last week.

While the report is directed to the board and there may thus be some defense of its form, it is none the less regrettable that it has been published to the membership as it now is. It contains some sixty recommendations mixed together irrespective of their importance, without separation of those that are of an essential character from those that relate to detail, without pointing out those that require constitutional amendment and those that may be expected to be put into effect automatically after new machinery is arranged. One leaves off the reading of the report in a confused state of mind that does not encourage analysis and study. With respect to form, the Joint Conference Committee's report is far superior to the rest of the document, for it lays down a set of conditions to be met and then spreads out a plan for meeting those conditions. This feature is not followed in the main report There is no setting forth of aims, there is no explanation of what is to be accomplished through the adoption of the various suggestions.

It is understood that the Committee on Development did submit to the board a statement indicating the ex-

sential features, but unfortunately this statement, if of a clarifying nature, was not sent to the members.

We stress so strongly the form of the report because we believe that it inhibits study of the document. We fear that it will not bring forth that volume of discussion and that intensity of interest which is necessary if the recommendations are to be adopted.

Turning to the matter of the report, the fundamental finding is that the society should confine itself to technical work and that while committing itself to the principle of becoming "an active national force in economic, industrial and civic affairs," should participate in these non-technical activities through delegate membership in a separate body—an enlargement of the Engineering Council idea. This view of the separation of functions will, we believe, receive general approval.

The individual recommendations fall into three classes: Those relating to (1) the change in the management of the society itself, (2) the broadening of its technical activities, and (3) the recommendations as to the type of federation in which the common work of all engineering societies may be joined.

The recommendations looking to the reorganization of the society are based on the theory that local strength in every section of the country is the real foundation of national strength. Each geographical district, under the recommendations, would nominate and elect its own members of the board of direction, local sections would be so organized as to cover every part of the country, each member of the society would be assigned to a section, each section would receive financial support from the parent body, and representatives of the sections would meet in annual conference to discuss the welfare of the society and to nominate candidates for the offices of president, vice president, and treasurer.

There can be no doubt that the demand for district organization is widespread. Legal obstacles must be met in making the board elective by individual districts, but certainly the membership will not be satisfied until this is done. The members outside of New York take the point of view that "where there is a will, there is a way," and that in some fashion, there can be devised a method by which the geographical districts shall have full control over the nomination and election of their own representatives.

There is a call, also, for the strengthening of local sections, but whether there will be support of the plan of the committee remains to be seen. There are some 6500 members (not counting those in New York City) who are not members of sections, and a considerable number of them must display enthusiasm for the plan. The subject is important and warrants fuller discussion than can be given here. Before leaving it, though, it must be remarked that its feasability is bound up with the matter of society finances.

With reference to the strengthening of the society's technical activities, the recommendations regarding papers should have general approval. There needs to be a broadening of the papers submitted, so that they will cover well the major advances in every one of the principal fields of civil engineering, while construction and financial subjects, hitherto receiving meager attention, need to be covered.

The committee work is built upon the local section framework, committees on important technical subjects being created in each local section. This is obviously an experiment, but one worth trying. As we look on the society, its greatest usefulness to the profession can be brought about through high-grade committee work. A complete abandonment of the idea of nationally formed committees would seem to be inadvisable until such time as the local-committee system had demonstrated its feasibility and strength.

Looking to the bettering of the society's technical service there are recommendations of additional general meetings, during which technical and "broad economic problems" are to be discussed, and of plans for recognizing the young members of the society. Space, however, will not now permit of the discussion of these matters.

With reference to the Joint Conference committee's report it should be remembered that the national engineering societies cannot divest themselves—and do not desire to divest themselves—of responsibility of seeing that civic and welfare work is actively taken up by the engineers of this country. Obviously, the logical method is to do it through some form of federation, hoping that we may work out a point of view that will enthuse the locals and bring them into active coöperation.

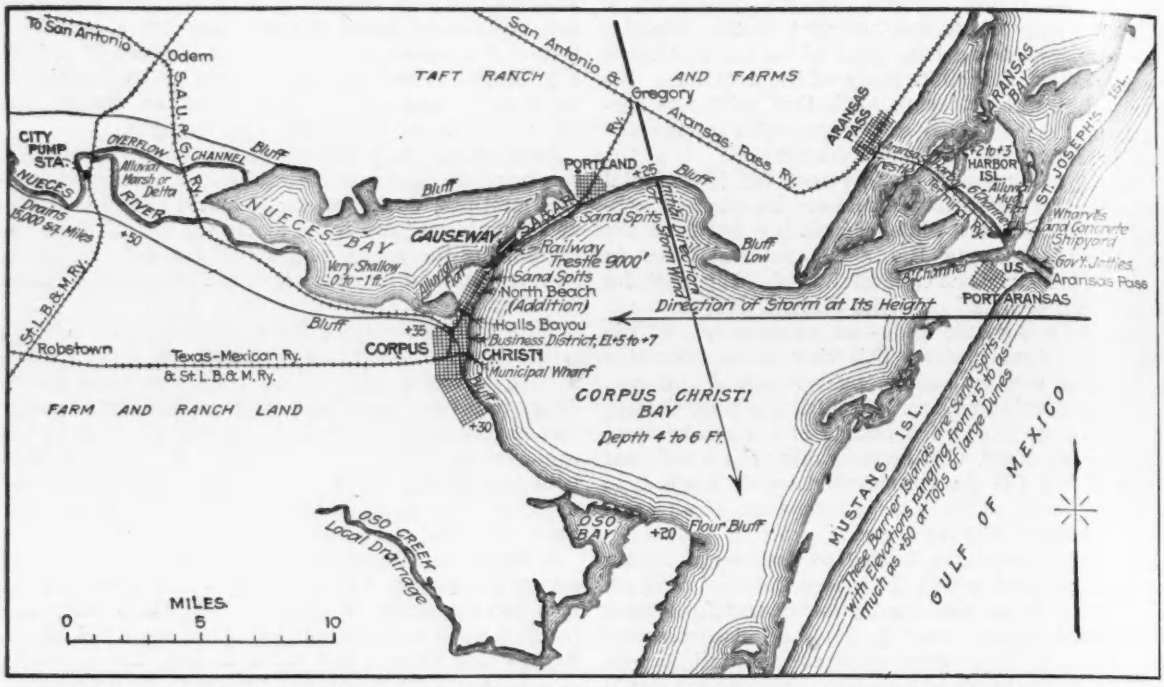
It should be recognized, however, that there must be strong propaganda to put the idea into effect. If we read the sentiment of engineers of this country correctly there is no enthusiasm existing for a federation. Engineering Council has failed to grip the sympathy of engineers. That was due largely to its detachment. The new body would overcome that in part but unless the proposed federation can put forth an inspiring program we foresee great difficulty in organizing it. There is nothing inherent in the idea of a federation that inhibits its success, but so far we have failed to find the method of doing it. The program as presented by the Joint Conference Committee does not strike us as being of the type that will appeal to engineers generally. Out of eleven activities recommended, two only have that personal-appeal character that is liable to excite much enthusiasm, and those relate to personal service work and to licensing.

Strong criticism has already been made of the proposed financing of the organization, through an assessment of $1.50 per member on the national societies and $1 per member on the locals. The revenues confessedly are inadequate for a broad prosecution of the manifold activities that might be taken up, but the belief of the Committee is that they would insure a good start and the possibility of so demonstrating what could be accomplished that larger funds would be forthcoming.

Taken as a whole, the recommendations of the body of the report appear to us sound. Some of them we propose to discuss in detail later.

As to the Joint Conference report, we believe that an enlarged type of federation should be proceeded with; but we feel confident that such an organization, to be made successful, will have to be dominated by a point of view quite different from that which dominates Engineering Council or is expressed in the Joint Conference Committee's report. Moreover, it will need not merely a change in point of view, but a very active propaganda among the local engineering societies to put the plan through.

Finally, one very important matter must have a forward place in the discussion—the recommendation that the dues of the society be increased. Unless larger funds are available the new activities recommended cannot be carried out.



LOCATION MAP OF CORPUS CHRISTI AND VICINITY SHOWING POINTS OF GREATEST STORM DAMAGE

The Tidal Storm at Corpus Christi and Its Effect on Engineering Structures

High Water Sweeps Over Barrier Islands, Relied Upon for Protection — Buildings Demolished — Serious Damage Done to Concrete Causeway

By Terrell Bartlett
of Bartlett & Ranney, Engineers, San Antonio, Tex.

THE most severe tropical storm and tidal wave known in the history of the Texas gulf coast on the morning of Sept. 14, 1919, struck and passed over the barrier islands and spent its full fury against the shores of the landlocked inner bays, overwhelming and sweeping away portions of the City of Corpus Christi, and the towns of Port Aransas, Aransas Pass and Rockport, and causing a property loss of many millions and a loss of life estimated at 350. The greatest loss of life and property was at Corpus Christi, the metropolis of the region, a beautifully situated and well improved city of 20,000 population.

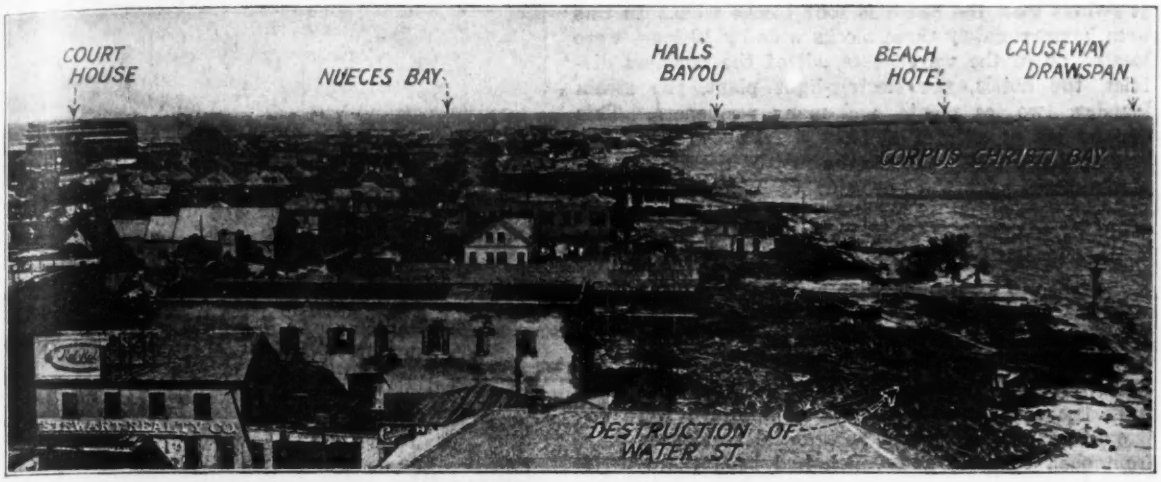
The large loss of life and great property damage was due to the unprecedented character of the storm and the great tidal height which surmounted the chain of coastal islands, hitherto relied upon to protect the towns built upon the shores of the shallow inshore bays many miles inland from the gulf. The loss of nearly 300 lives at Corpus Christi was entirely needless, as the Bluff portion of the city, where the principal residential section is located, 35 ft. above sea level, afforded opportunity for entire safety to the dwellers on the low ground, had they had any conception of the necessity for seeking refuge there. This false sense of security was accentuated by the report of the United States Weather Bureau observer that the storm would be of less intensity than that of 1916. This report was correct as respects the wind velocity, which reached a maximum of only 80 miles per hour as against fully 100 miles per hour in 1916.

The unprecedented feature of the recent storm was in the extreme tidal height which, at Corpus Christi, reached a level of 12.4 ft. above mean low tide as against 5.9 ft. in 1916. The ordinary tidal range is from 1.0 to 2.0 principally from wind action, which largely obliterates the small lunar tides. The storm was a typical West Indian hurricane, with a comparatively moderate wind intensity, but covering a large area, which doubtless accounts for the extreme tidal height.

The storm was undoubtedly much more severe than the Galveston storm of 1900, for its effect after passing the outer islands, which must undoubtedly have partly broken its force, was comparable with or more severe than the one at Galveston, situated on an island similar in all respects to Mustang Island. The town of Aransas Pass, on Mustang Island, was entirely destroyed. The loss of life there was small because it was deserted upon warnings of the approach of the storm.

The first indication of the storm was a wind from west of north. Its intensity became threatening at about 10 a.m. on the morning of Sunday, Sept. 14. At 9.45 a.m. the United States Weather Bureau observer, acting because of rapid barometric drop, issued a warning to all persons in low places to seek refuge on high ground. The low barometer reading was 28.65.

By 10.30 a.m. the wind had reached a velocity of 70 miles per hour, and the water had commenced to flow over the bay front in Corpus Christi. From then



LOOKING NORTH FROM NUECES HOTEL—PRACTICALLY ALL RESIDENCES BEYOND LINE FROM COURT HOUSE EAST TO BAY ARE TOTAL LOSS

LOOKING SOUTH FROM NUECES HOTEL—WATER STREET DESTRUCTION (CENTER) AND MUNICIPAL WHARF (BACKGROUND)

until 12.30 or 1 p.m. the wind increased in intensity and gradually veered to the east, reaching a maximum of 80 miles per hour, which was maintained until about 4.30 p.m., when the wind commenced to abate and to veer to the southeast, and finally to the south. The water rose rapidly until 1.45 p.m., when it was nearly at the greatest height; the final maximum water level was reached at 4 p.m. and remained until about 4 a.m. the next morning, when it started to recede slowy. The water was not out of the streets in Corpus Christi until the morning of Tuesday, the third day. The storm was accompanied by a driving rain and mist of salt spray. The rainfall was 3.3 in. during the first day.

The tidal wave which swept over Mustang Island and Harbor Island brought with it large quantities of beach logs, wreckage of buildings from Aransas Pass and heavy timbers from the wharves and shipyards on Harbor Island and the trestle of the Aransas Harbor Terminal Ry. Surfaces were covered with heavy asphaltic oil from steel storage tanks which were wrecked at Harbor Island. This oil somewhat abated the sharpness of the waves but made difficult the task of identifying the dead.

The damage done was the result of the combined force of waves, floating timbers and wind, all acting jointly and with progressively increasing effect as successive destruction added to the mass of driven wreckage. The damage from wind alone was limited to breakage of windows and other minor results of flying débris. The height of waves, trough to crest, is estimated by seafaring men in Corpus Christi at from 10 to 12 ft.

At the southern extremity of Corpus Christi, where there was only a narrow beach and where all improvements were on top of the 30-ft. bluff, there was no damage to buildings. However, we find here and likewise on the bluff each of Portland, on the north shore of Corpus Christi Bay, the most striking evidence of the fury of the storm, for these clay bluffs were cut away wholly and bodily for depths as great as 100 ft. and for an average of at least 50 ft. Houses which were back from the edge of this bluff by the width of a roadway and yard now stand on the brink. Northward along the shore to the municipal wharf (see map) a point is reached where the beach is two blocks wide, and thence northward to the point of the bluff where

it swings west the beach is four blocks wide. In this area, approximately three blocks wide by 10 long, were located all of the warehouses, all of the business district, the hotels, the electric-light plant, the steam laundry, two ice plants, and many residences. This district lay at a level of from 5 ft. above mean low tide at the shore to 8 ft. at the foot of the bluff, three blocks back. On the bay side of Water St., which closely followed the shore line, were numerous resort pavilions, fishing and other light wharves, and on fills inclosed by light sheet piling, one large brick building, one of the ice plants and several resort pavilions. All of these were totally destroyed, although the heavy machinery of the ice plant stands on its concrete pile-supported footings. Practically all of the round piling under these structures remains. In the first block back from the shore nearly all frame buildings were destroyed as well as several substantial residences built from shell concrete and which had been there three generations.

With the exception of two one-story brick buildings fronting east on Water St., and the power plant of the Nueces Hotel, which were not structurally damaged, everything in the first half block, or 200 ft. from the shore line, was totally destroyed, not including the light plant, from which some machinery can be salvaged. The brick business houses and the Nueces Hotel, a six-story reinforced-concrete structure on pile footings, on the inner half of the first block and fronting west on Chaparral, the second street, were not structurally damaged, but all the lower floors were flooded and many of the back or east walls were destroyed.

The wreckage was thrown up in Chaparral St. in a great drift pile which evidently protected to some extent the second and third blocks back, where the damage was limited, in the business district, to that done by the water, the heavy oil and the breakage of glass store fronts.

Municipal Wharf Damaged

The municipal wharf at the shore end consisted of a sand fill inclosed in a heavy Wakefield-pile sheeting, with heavy waling and round pile supports at intervals stayed to deadmen under the fill. At the outer end it was inclosed by concrete construction, consisting of 4-ft.-diameter, grooved cylinders which were constructed

DEMOLISHED CONCRETE BLOCK CONSTRUCTION 150 FEET INLAND

inside steel forms, sunk several feet below the old bottom and concreted. Between these cylinders were tightly joined driven concrete sheet piles whose tops were held in place by a heavy concrete waling girder or coping fitting into the cylinders. This fill, about 200 ft. wide, extended out into the bay 600 ft. The timber sheet piling was left intact, as well as the concrete sheeting along the sides. Across the outer end the concrete waling was largely destroyed, and many of the concrete piles were broken off down to the bottom. Beyond the filled portion at the outer end was a timber T-head landing wharf of heavy creosoted timber construction on piles. The deck and caps are entirely gone, the piles only remaining. The floor of the entire municipal wharf structure was at about El. 6.0.

On the filled portion of this municipal wharf were located a cotton compress, a railway spur and a large framed sheet-iron-covered cotton warehouse. None of the buildings remain. The heavy compress machine itself still stands, as does the boiler, whose brick incasement is practically gone. The 14,000 bales of cotton which were on the wharf were scattered everywhere

DEBRIS AT SITE OF ELECTRIC LIGHT AND ICE PLANT

along the shores of Corpus and Nueces Bays. They undoubtedly caused considerable damage.

Further northward along the shore, from a point opposite the angle in the bluff to Halls Bayou, all residences in the first block from the bay were destroyed, practically all having been floated off and damaged beyond repair. A concrete-frame brick schoolhouse just south of Halls Bayou is structurally intact, although its brick walls are badly battered in the lower story. Through this stretch a ridge of shell some 6 or 8 ft. high was thrown up along the beach.

Halls Bayou is an old channel or break through the beach carrying water, at times of ordinary high tide, to a depth of possibly 2 ft. and a width of 20 or 30 ft. It had been filled and the low ground covered with

BACK OF BRICK HARDWARE STORE 300 FEET FROM BAY

frame cottages. The North Beach Addition, so called, had been built up during recent years, with three or four hundred residences, mostly cottages, scattered over the three or four blocks next the beach on Corpus Bay—the highest land. The level of this sand spit ranged from El. 5 at the beach crest to El. 2 at the back shore line.

From Halls Bayou to the foot of the bluff at Portland, across the bay, the storm exerted its greatest destructive force, for to all of the forces acting along the shore in the business district of Corpus Christi below the bluff was added the suddenly rushing current of water across the low sand spits and through the shallow channel between them into the basin of Nueces Bay, lying between the bluffs on either side. At the upper end of this funnel-shaped basin the rush of waters raised the level at the city pumping plant to El. 13.9, which was 1.5 ft. higher than at Corpus Christi. The current swept on up the river channel meeting the flood from the rainfall dropped inland by the storm over the entire Nueces watershed and causing unprecedented flood levels in the lower river valley.

The North Beach Addition was swept clean. From Halls Bayou north there remained, with three exceptions, no vestige of a house, not even a brick footing block. There still exist a part of a two-story frame sanitarium, the badly battered remains of another two-story frame house, and the four-story, concrete-frame hotel building now occupied as a Government hospital—all situated on the crest of the beach. The first story front (east) and rear brick walls of the last building were totally destroyed, while the concrete columns were left apparently intact.

All three of these buildings served as a refuge. The greatest loss of life occurred in this section of the city. During the later hours of the morning of the storm many persons were taken out of this section in automobiles sent for that purpose, but many refused to leave their homes and others were cut off early in the storm by the breaking of the water through Halls Bayou.

The bodies from this section were mostly recovered along the north shore of Nueces Bay. A few persons were carried across on floating wreckage and rescued there. There were no buildings and no improvements on the beach or sand spit on the Portland side save the San Antonio & Aransas Pass Ry., and the highway.

Municipal and Railway Improvements Affected

The loss suffered by the municipality of Corpus Christi was confined to one block of paving undermined and destroyed on Water St., the damage of many fire hydrants by wreckage, and the washing out of sections of storm sewers which lead down the badly eroded South Bluff.

The track and ties of the San Antonio & Aransas Pass Ry., from a point south of Halls Bayou to the foot of the bluff at Portland, a distance of seven miles, were entirely swept away. The railway's embankment across the sand spits was for the most part destroyed. All stringers and many caps and a few of the pile bents in the railway's trestle were swept away. The San Antonio, Uvalde & Gulf crossing of Nueces Bay further west was similarly destroyed for 12 miles. The 30-ft. bascule draw span in the S. A. & A. P. trestle was on a deep concrete pier and was not damaged.

Causeway Nearly Complete Ruin

The causeway connected the two sand spits across the inlet between Corpus and Nueces Bays. This structure was completed in 1915 under the plans and supervision of the writer's firm, Bartlett & Ranney, engineers, San Antonio, Tex. Following the experience of the Texas coast for a century, which indicated that gulf hurricanes spent their force on the outer islands, and in common with the practice along the low interior waterfronts for several generations, reliance was placed on the supposedly protected location. A comparatively low and light concrete structure was therefore, built across the 8500-ft. gap of shallow water at a cost of $160,000. This structure was described in *Engineering Record* of Mar. 18, 1916, p. 390. It consisted of 2500 ft. of reinforced-concrete girder spans at the south end over water 4 ft. deep at high tide, and 6000 ft. of unprotected shell embankment across the somewhat shallower northern end. The structure paralleled the San Antonio & Aransas Pass Ry. trestle on the west side at a distance of 120 ft.

The causeway was almost totally destroyed. The draw, a Strauss bascule of 35-ft. span seated on pile-supported piers carried well below the old bottom, is intact. There still remain 22 out of 75 of the concrete-capped supporting bents. The remaining concrete girders—in many cases two or three of the continuous spans are still more or less integral—now lie from 125 to 200 ft. west of the original location. There appears to be very little of the destroyed concrete under the

old location. The floor was at El. 9.0, with a light concrete rail a little more than 3 ft. higher. The floor and rail were therefore at the level of the waves.

The girders were supported on bents of heavily creosoted piling, seven piles to a bent, cut off at low water, with a heavy concrete cap 2.5 ft. wide covering and incasing the pile heads from El. 3.0 down to the old bottom level at El. 2.5 to 3.0. The piles were of the same length as those in the S. A. & A. P. trestle alongside, which have stood some 30 years, but were driven 6 ft. deeper. At points where the penetration under driving was not satisfactory the piles were spliced and two lengths driven and jetted down. In all cases the splices were at least 20 ft. below the original bottom.

The girders and floor were built in continuous series of five spans of 32 ft. each, separated by an open joint over the center of each fifth pier or bent. The load on these expansion joint piers was exactly the same as on the intermediate piers, and the adjacent girders were the same as in the intermediate fully continuous spans, except for the necessary increased reinforcing. The girders were not tied in any way to the concrete pier caps, the concrete being simply run directly against the previously placed cap except at the expansion joints, where a horizontal layer of tarred paper entirely separated the bearing surface of the girders from the concrete pier cap. The structure had an unexpected and severe test in the storm of 1916, which was itself unprecedented, without the development of any evidences of settlement or cracks whatsoever. The bottom under the filled portion, which was undoubtedly swept away early in the storm, is at substantially its original level, while under the bridging there is an average scour of approximately 5 ft., notwithstanding that there is no considerable change in the original bottom under the adjacent railway trestle.

From these facts and the further rather surprising evidence that all of the bents and pier caps, which were under expansion joints remain practically intact without sign of settlement, whereas practically all of the other bents have totally disappeared—cap, piles and all—what happened to the structure seems fairly evident.

Apparently the railway trestle, deck and rails which were at El. 7.0, went out first, and the filled portion of the causeway, railway stringers and track, together with drift and wreckage from a distance, were thrown against the concrete deck, forming with the structure a considerable obstacle to the force of the storm and thus forcing a strong current under the bridge, which remained long enough for the deep scour to take place. The lowering of the bottom increased the leverage strain on the piling below the concrete cap, and the force of waves and current acting obliquely against the structure and the collected wreckage broke the piling and forced the bents over longitudinally with the bridge. The bents at expansion joints were saved by the ease with which the ends of the girders could be pushed off the supports.

A detailed survey of the conditions will be made shortly by the county engineer, which will doubtless bring to light many interesting facts concerning the failure of the structure. A highway crossing of a type as yet undetermined will be built at once by Nueces County.

The principal lessons to be learned from this storm are the great tidal height possible with one of the West Indian hurricanes, and—what has never before been demonstrated—the fact that the outer or barrier islands do not afford certain protection to the inner shore line.

Plans had been prepared and funds provided by the City of Corpus Christi to the extent of $600,000 for a sea-wall to afford protection against such a storm as that of 1916, which until last month was considered the worst to be anticipated. Fortunately, this construction had not been begun, for the work proposed would have availed nothing against the recent storm.

Many suggestions as to the future development of the city have been made, but as yet no definite policy has been crystallized. It seems certain that no new residences, except cheap summer camp cottages and amusement pavilions, will be built in future on low ground and that probably the new business construction will likewise be placed on the high ground of the bluff, where there is unlimited space for the development of a city of any size. Whether an effort will be made to protect the considerable remaining business property by a massive, high, sea-wall, with or without grade raising, has not been determined. Repairs to damaged stores and residences are proceeding rapidly and business is now going on in the city practically as usual. Many shopkeepers and people of moderate means have lost everything. The liberal relief funds which have been donated to the stricken community have been

NORTH BEACH HOTEL, SHOWING WAVE DAMAGE TO BRICK RAIL ON SECOND FLOOR AND WIND DAMAGE TO ROOF COPING

sufficient to prevent destitution, but not enough as yet to aid the community materially in its effort to start rehabilitation to its former condition of prosperity.

The writer wishes to express his appreciation of assistance rendered him in preparing this article by H. A. Stevens, county engineer of Nueces County, and C. J. Howard, city engineer of Corpus Christi.

Tests on Structural Gypsum Reported

In a paper entitled "Tests of Plain and Reinforced Gypsum Specimens," presented by W. A. Slater and J. J. Whitacre, published in the *Journal of the Western Society of Engineers* of September, 1919, there is an elaborate report of a series of tests made on plain and reinforced gypsum. The paper is quite lengthy and contains a vast amount of information regarding the physical properties of gypsum when used as a structural material.

First Valley Closure of Miami Flood Protection System Completed

CLOSURE of the Twin Creek Valley, 15 miles southwest of Dayton, Ohio, by the earth embankment of the Germantown dam, was accomplished successfully two months ago, and more completely by Nov. 1, when the closure section had been brought up level with the previously constructed main part of the embankment. Hydraulic-fill work is now proceeding at maximum rate, two 10-hour shifts being worked, in order to raise the height of the embankment as much as practicable before pumping is interrupted by winter weather. There was some apprehension that the rapid progress of the core-fill work might create a dangerous hydrostatic head within the embankment, but observations on the core material have dispelled this; the core has very satisfactory solidity. Moreover, an ample factor of safety is provided by limiting the width of core and thus obtaining plenty of stable, coarse material in the outside slopes. At present the embankment is about 35 ft. high above the stream bed. The volume of the reservoir and the discharging capacity of the outlet conduits at present will take care of a run-off of about 2½ in. in 24 hours over the entire drainage area of Twin Creek above the dam, corresponding to an unusually severe flood.

This dam is to be an earth embankment of 107-ft. maximum height of 1210-ft. length, pierced by a permanently open twin outlet conduit of which each half has an arched section 9 ft. 5 in. by 12 ft. 3 in. A spillway through a natural gap near one end of the dam, 10 ft. below the dam crest, defines maximum water level in the reservoir. The outlet conduits, founded on rock, were completed by April of the current year; in order to double their discharge capacity as a safety measure during construction, they were built twice their final height, having their present floor 10 ft. below the future permanent floor. After they were completed, embankment construction began on the full length of the dam except at the creek crossing, the embankment being terminated here for the time being by a low cross-dike. The creek gap provided a safe flood channel during the slow work of building the main part of the embankment to a height safe against overtopping, and closure of this gap could then be carried out rapidly.

In order to accomplish the closure this season, preparations were begun in September. Under protection of a light earth dike thrown across the creek upstream of the dam, a cutoff trench was dug along the center line of the dam; the creek bottom was cleaned off and then covered with a 4-ft. layer of rolled and puddled fill upstream from the cutoff trench. This work, interrupted by freshets, required a month, after which embankment construction in the gap was started and carried along rapidly. The protection dike along the upstream toe of the dam was first brought to a height of 15 or 20 ft. by dragline dumping; between this and a lower dike at the downstream toe, hydraulic fill was pumped, pumping into the main part of the embankment being stopped for the time being. About six weeks' pumping brought this closure section to the height of the rest of the embankment, or 35 ft. above stream bottom.

The rapid rate at which filling is required to progress in this closure section, because of the relatively small basin area and the fact that the watershed is steep and therefore more subject to high water than the other streams, made the Germantown dam the most difficult of the district's five dams with respect to valley closure. However, a very satisfactory degree of consolidation of core material has resulted even in the rapidly built-up closure section, and the dam has now been carried to a height where it cannot be topped by a flood of even the magnitude of that of 1898.

The Germantown dam is being built under the immediate direction of Arthur L. Pauls, division engineer; C. O. Shively, assistant division engineer, and Albert Armstrong, superintendent.

Year's Work in Reclamation Service

DURING the fiscal year ended June 30, 1919, the United States Reclamation Service, according to the recently published annual report of the Secretary of the Interior, accomplished the following results:

1. Continued the construction and operation of irrigation works capable of furnishing water to 1,602,000 acres of arid land and actually irrigated in 1918 nearly 1,120,000 acres, covered by project statistics, producing crops valued at over $66,000,000.

2. Increased the area irrigated and covered by crop census 93,000 acres over that of the previous year.

3. Operated irrigation works including 40 reservoirs, several power and pumping plants, over 12,000 miles of canals and drains, as well as pipe lines, flumes, and tunnels and thousands of structures, such as dams, headgates, weirs, checks, drops, etc.

4. Continued the extension of the projects, including the construction of 396 miles of canals, 179 miles of drains, and nearly 8000 canal structures, and excavated 14,000,000 cubic yards of earth and rock.

5. Continued the standardization of the numerous irrigation structures in the interest of economy and the efficient operation of projects.

6. Continued the policy of stimulating crop production by expending construction funds where they would most quickly increase the productive area of the projects, by active coöperation with the farmers in leveling and otherwise preparing their lands for cultivation, by temporary leasing of withdrawn lands not yet ready for irrigation for dry farming and grazing purposes, by disposal of stored water to lands outside of the projects whenever it would result in increased production and would not jeopardize the project supply, and by encouraging better storage and marketing facilities.

7. Coöperated with other departments of the Government, with other bureaus of the Interior Department, with state governments and with numerous local project organizations in the furtherance of reclamation work and the interests of the water users.

8. Carried on a survey of soldier-settlement possibilities throughout the United States resulting in the location of probably feasible projects in practically every state, ranging in area from 5000 acres to over 200,000 acres.

Rapid Seasoning of Timber by Kiln Drying

Seasoning wood quickly by kiln drying is an important matter in many wood-using industries, but the United States Forest Products Laboratory finds that few kiln operators attain the fastest safe rate of drying, and that quick satisfactory drying depends more on the operator than on the kiln. It is found within the limit of commercial possibility for 1-in. lumber to be kiln-dried from 18% moisture content (as reached in three months' yard seasoning) to 5% moisture and conditioned for use in 5 to 7 days for hard maple and birch, 6 to 8 days for red gum, walnut and mahogany, and 8 to 10 days for plain sawed oak.

Paving Brick Manufacturers Seek Specification Changes

Lugless Brick, Standard Sand Cushion for Bituminous Fillers and 4-Inch Base, Are Among Features Proposed

THE National Paving Brick Manufacturers' Association has adopted new specifications for standard vitrified paving brick that contain two new features. The first is that the brick "shall be wire-cut and shall have square edges," and the second provides for a reduction from the standard 3½ x 4 x 8½-in. brick to 3 x 4 x 8½ in. While the language of the specifications with reference to the kind of brick specifies that they "shall be wired-cut and shall have square edges," the association explains that its intent is a standard plain—that is, a lugless, brick.

In the specifications covering the laying of pavements, the association recommends that sand cushions be made standard for bituminous fillers, a cement-sand bed, however, being retained for use with cement fillers. Recommendation is also made that the minimum depth of concrete base be reduced from 6 to 4 in.

These four recommendations, two relating to the brick itself, one to the type of cushion, and the fourth to the base, were presented by the association to the Brick Committee of the American Society for Municipal Improvements at its New Orleans convention Nov. 13. The proposed specifications, however, were not acted upon by the committee or, at least, were not reported out to the floor of the convention.

In presenting the matter to the American Society of Municipal Improvements, the association gave the following reasons for the recommended change:

"1. Economy in manufacturing costs by eliminating higher cost incident to producing many varieties of the same article.

"2. Insuring the production of the highest possible percentage of No. 1 brick, uniformly and thoroughly vitrified beyond all service requirements.

"3. Convenience, by affording a uniform brick available from any and all manufacturers.

"4. Providing a larger possible measure of economy in brick pavement construction by reducing the weight of brick per square yard approximately 25%, when laid flat."

Need for standardization is due, says the association, to the following facts:

"The paving-brick industry is now producing more than 12 different styles of brick for street and highway surfaces.

"The capacity of the industry is approximately 3,250,000 tons annually. Coal consumption amounts in round numbers to 6,000,000 tons in a year.

"Even a comparatively slight relative economy applied to these figures means much in absolute value.

"The need for utmost economy, as measured by the lowest possible production costs, is vital as a national service. This applies to all industries, paving brick included."

Added service value can be secured, says the association, because "careful grading of product to meet the standards of quality for street surfaces leaves off grade material," inasmuch "as the percentage of off-grade material is reduced by a larger proportion of No. 1, manufacturing costs are lowered."

Added reasons for the proposition of changes in specifications are, says the association, that the "size and character of standard brick we propose to the society is the one that lends itself to uniformity in structure and vitrification with minimum weight. While standardization of product is conceded to be essential, it naturally should not be accomplished at the cost of loss in service value. It should (and in this instance, will) bring added service value.

"The convenience to buyers of being able to secure the same size and character of product from any manufacturer is evident on the face of it.

"Reduction in weight per square yard wherever transportation and handling are involved is a readily recognized advantage in aiding more economical construction."

Continuing, the association proposes "that it clearly be stated in the specifications of the society that sand is preferred as a cushion material, jointly with granulated slag and stone screenings (as representative of the same type of cushion) when bituminous fillers are used.

"This recommendation is in effect a positive statement that would define the usefulness of sand as a cushion material, lest the fact that general usage of the sand cushion and cement grout filler has been abandoned be construed as discrimating against sand cushions.

"It opens the door to the next logical recommendation, that a specification be admitted for the cement-sand bed to accompany the use of cement filler.

"The amendments are proposed in accord with general practice now prevailing in all sections of the country.

"The proposed reduction in the minimum depth of concrete base for brick pavements is made, believing that it is the desire of the society to place its specifications at the service of engineers in all communities, large and small.

"Without question, there ar streets in cities that logically require bases as deep as 6 in. when concrete is used.

"But there are many more conditions where 4 in. is quite sufficient for all requirements. Using 6 in. would then be an extravagance.

"Must we not think in terms of the combined subgrade and artificial foundations? May we not say that first attention should be paid to secure a thoroughly well drained and stable subsoil?

"With that assured, the function of the base is more to distribute loads than to support loads.

"If for no other reason, the fact that 4-in. bases are now and have been for many years in actual service, without the slightest question as to adequacy, would supply all the evidence needed in support of this recommendation. After all, we are merely speaking of minimum depth."

Fairbanks District Gold Yield

The Fairbanks district, in the Yukon basin, has produced over $70,000,000 in gold and has been a source of considerable silver, lead, tungsten and antimony.

Stacking Elevator Simplifies Freight Handling

Heavy Bales and Boxes Lifted Into Place at Low Cost by Self-Driven Electrical Machine Developed at Seattle

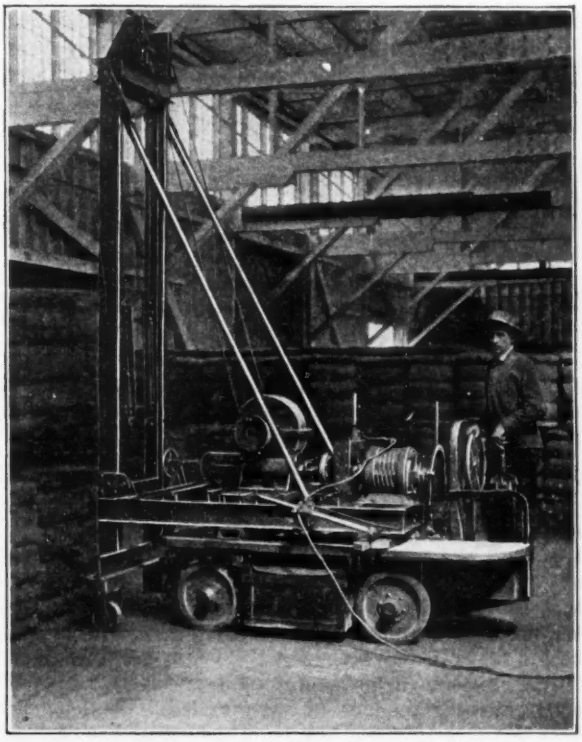
GUNNY bales, weighing from 1400 to 2000 lb., are received in large shipments on the piers of the Port of Seattle. So long as these did not need to be piled, no freight-handling problem was involved, because one man unaided, with a two-wheeled truck, could deliver the bales at the desired place and at a very low cost. As floor space became more valuable, however, it was necessary to pile the bales two high. The labor cost then increased enormously, because it took 10 men to lift the bales to the second tier.

A study of the problem undertaken by G. F. Nicholson, chief engineer, and G. Whitestone, electrical and mechanical engineer of the Port of Seattle, resulted in the development of a portable stacking elevator which has greatly reduced the cost of unloading cargo of this character. The device resembles a miniature motor-driven piledriver with a steel platform operated in the leads in place of a hammer, the entire apparatus being mounted on an electric truck. The truck is of standard type, operated by storage battery, and when it is desired to use the truck separately the clamps which hold the steel frame to the truck body are removed and the pair of pivoted struts at the rear is swung down to bear on the floor. The truck can then be run out from under the elevator mechanism proper.

The mechanism consists of an electric motor geared to a pair of drums on which are wound the hoisting cables that operate the platform. The gear ratio can be suited to the speed required. For handling gunny bales and general freight, a lifting rate of 60 ft. per minute has been found suitable. The lifting capacity is about 3000 lb. The motor is served by an extension cord from the nearest outlet in the power circuit, but if desired a motor could be used which would be operated by the storage battery. The controller for the hoisting motor is provided with an automatic cutoff actuated by a cable carrying adjustable stops. This arrangement shuts off the power and sets the brake at a predetermined point. The leads are hinged, so they can be laid back to permit the machine to go through doorways. For use in narrow aisleways a turntable has been designed to be placed between the truck and the elevator proper. This allows the elevator to be swung around at right angles to the truck, in which position it can handle freight equally well.

For handling gunny bales the machine is placed in the center of the shed floor, and truckers with their two-wheeled trucks deliver the bales to the machine platform. In this way the machine can work as many as six piles at a time. The steel platform comes to rest on the floor, and onto this the man with the two-wheeled truck dumps his load without help. The platform then elevates the bale, the machine is moved to the desired location, and the platform is thrust over the lower tier of bales. While the bale is held in position over the pile the machine backs off. To aid further in finally placing the bale, the platform is slightly elevated and pushed against the bale while the men guide it into place. This operation is very rapid and is said to eliminate at least six men from each crew engaged in putting gunny bales on the second tier. The machine also makes it possible to extend the piles several tiers if desired at practically the same cost as for the second tier. Piling gunny bales in three tiers by man-power would be impracticable because of the excessive labor cost.

An ordinary storage battery truck in this service is found to operate approximately 12 hours without recharging. When a direct-current motor is used on the elevator and draws energy from the truck battery, the length of service for each recharge is reduced by about



LIFTING 2000-POUND BALES WITH A MECHANICAL STACKER AT PORT OF SEATTLE

25%. However, the use of a motor connected to the storage battery is recommended by the Port of Seattle authorities, because it eliminates the extension cords and the need for power wiring.

When the first stacker was put in operation on a gunny-bale cargo, a record of cost data showed a saving of about one-half over the usual cost of handling the bales. The cost of unloading this cargo was $5000. If five stackers had been available, one for each of the boat's five hatches, port authorities stated the cost would have been reduced to $2500. Enough machines are to be added to the two now in service to permit the handling of an entire cargo by this means.

The machine has been effectively used for stacking canned salmon, with the aid of four wheel trailers on which the salmon cases are loaded, a light wooden bottom being placed first and the stack piled on this. These trailers are loaded at shipside and drawn by electric trucks to the stacker. The steel platform of the elevator is run underneath the wooden bottom, and the load is lifted to the desired height, whence the cases are removed by hand. This method releases the trailer as soon as it reaches the stacker and is relieved of its load.

The American Highway Problem

President A. R. Hirst's Address Before the American Association of State Highway Officials, Louisville, Kentucky, December 8, 1919

WE COMMENCE today, in this our annual meeting, what I sincerely feel is the most momentous highway gathering ever held in America. For the past few years the overwhelming shadow of the world war has hung over all our deliberations. Everything else was so secondary to the issues fought for and won in that great struggle that even those of us who most implicitly believed in the importance of highway work in America felt that highways and work upon them should be subordinated to the other and greater world purposes.

We did, however, fight, and fight successfully, in order that the great highway movement be not utterly crushed in the midst of the manifold demands of war, because we felt that by keeping together the nucleus of a highway organization, despite many shortsighted attacks, we were doing the American people a real service. It was not pleasant work, or profitable, to those of us who were in the midst of the storm. But it was worth while, and the fight was won, even though for a time the production of ukuleles was ruled, by the powers that be, to be more important than the production of highways.

The New Era

But now all is changed. The American people, almost as one man, are demanding, and that instantly, a modern and comprehensive system of highways, and are willing to pay the price. They have at last realized that the price of building highways which will serve the needs of the present and of the logically to be expected traffic is far less than the price they must pay if the present embargo of mud continues. Never, I believe, since the days of early railroad development have the American people been so determined to change instantly their means of transport, and not even then were they so willing to pay the cost, provided they could get the results. What are the results they are now demanding, and what are some of the problems that grow from these demands?

They are expecting the states which had no highway organizations three or even two years ago, which had done no preliminary work and in some of which hardly a mile of modern rural highway had ever been built, to create an organization full-sprung from the earth (as our imaginary defensive and aggressive Army was to spring) and to build instantly hundreds of miles of modern roads costing millions upon millions of dollars. In the older states in the highway game, better prepared with organizations and contractors, and with some knowledge of material and construction conditions, they are asking us to double, triple or quadruple our annual output of roads. It is probably fair to estimate that the expenditure for modern highways in rural America in 1919 was about $200,000,000 and that the sum desired to be expended for them in 1920 exceeds $600,000,000. In other words, the people of America desire to triple their highway expenditures and to do it in one year.

We are wont to think of the era of railroad building in America as presenting the greatest of engineering problems and that its solution was an astounding exhibition of the capacity of American engineering genius. However, the problem confronting American highway engineers today far exceeds the old one in magnitude. In the record five years of railroad development (1879 to 1883, inclusive) there were built 40,000 miles of railroad costing, as nearly as I can ascertain, about $20,000 a mile, on the average, or $800,000,000 in all. In the five years from 1920 to 1925, inclusive, the American highway engineer will be expected to build probably 100,000 miles of highway costing not less than $3,000,000,000. Even allowing for the depreciated dollar, the yardage of earth to be moved, the amount of materials to be furnished and transported, and the labor required are probably at least double those required in the former enterprise.

Some of Our Problems

It may be of interest to list some of the tremendous problems facing the executives of state highway departments in this work of speeding up the national highway program to meet the American demand:

1. *Trained Engineering Help*—The problem of trained engineering help to make the surveys and plans, the preliminary investigations and to perform the inspection is one largely for American educators, but with the present shortage and the very restricted output of young engineers, due to the war, it is an acute one demanding immediate attention. I might add that, in my opinion, a four-year course is longer than is necessary for the preparation of much of the help that is needed, and a solution should be sought along the lines of the winter short courses of our agricultural colleges. We must have hundreds—yes, thousands—of trained men at the earliest possible date and four or five years hence will not do.

2. *Materials of Construction*—Nothing is more certain than that there will be an acute shortage of materials in 1920 and thereafter, unless there is substituted in place of the present hit-and-miss methods an intensive study of all available road materials in every state, and unless the most strenuous methods are used to develop every available source of supply. The expensive production and delivery of road materials during the winter season is going to be necessary, especially in the northern states with short construction seasons. Every state must establish a road-materials department, the sole function of which will be to locate, test, develop and arrange for the proper delivery of all available materials. Already there are rumors of combinations of material men to purchase and control all sources of highway materials. It is up to the states to protect their people by getting sufficient material sources in state and county hands before it is too late.

3. *Cement*—It seems obvious that much, if not all of the so-called permanent surfacing will be either cement concrete or other surfacings on a cement concrete base, and that practically all drainage structures will be built of concrete. Unless there can be had the most absolute and fair Federal control of the price of cement, the bidding between municipalities and states

and between contractors for cement is apt to drive the price up to the point of impossibility. In lack of Federal control, the erection or purchase by the states of cement mills or state control of the output of certain mills would seem to be only a rudimentary conception of the duty of protecting the public against unduly inflated prices. The present unfair arrangement between manufacturers and dealers whereby dealers who never see or handle the cement must be paid hundreds of dollars for every mile of road built of concrete or with a concrete base must also be controlled effectively. States which buy millions of barrels of cement annually and pay always (no bad accounts) must get at least the dealer's price.

4. *Car Service*—Car service has been execrable on practically every railroad. We have been handicapped day after day and month after month by the criminal neglect of the present railroad officials to recognize the fact that highway building is a great American industry. If construction is to be carried on with materials delivered by rail, better car service, and, in the northern states, a longer season for shipments, are necessary. Possibly the time will soon return when freight revenues will mean something to American railroads and when it will not be an insult to a railroad man to offer his company freight business. I sincerely hope so. Until then we ought not depend on materials involving a railroad haul except where no other source of supply is humanly possible. If the railroads are allowed to come out of their present state of coma and will give us the proper type of cars, enough of them, and reasonable service at fair prices in the installation of unloading sidings conveniently near the work, their revenues can be very materially increased, our costs decreased, and our work speeded up.

Railroad Problem Demands Attention

Who but a hopeless theorist could have devised the present system of railroad control wherein it is no one's business to get business, and the less business a railroad does the less the wear and tear on its roadbed and equipment and the greater its real profit? If you guarantee a man a fixed income for a term of years, whether he does much, or little, or nothing, what is the inevitable result?

And yet it is seriously proposed to continue the present soporific arrangement, which has killed all railroad initiative, hamstrung all legitimate business and left us a nation with its primary circulatory system fitted with a tourniquet on every artery. The latest farseeing exhibition of genius is the granting of time and a half for overtime on slow freights, whereby it is happily made possible for every freight train crew to increase its earnings greatly by making slower time!

Even in this railroad problem we must interest ourselves because we can never build our roads unless this American "sleeping beauty," our railroad system, is given an injection of dynamite and made to live again.

5. *Efficient Construction Organizations and Fair Prices*—The contracting problem we always have with us. We need every competent highway builder available and we need immediately to multiply his number two to five times in the various states. We must encourage those good contractors who are now available and develop many new ones. To do this, good prices will have to be paid and fair treatment given. On the other hand, we must not hand over our clients' pocketbooks to the contractors with the injunction, "Take what you think is right, but please return us the cover." Unless some restraint is exercised, with the amount of work there is to be done and with the universal feeling existing that "my road must be built no matter what it costs" prices will be driven up and up, without regard to proper cost, values or profits.

In this connection, it is my belief that each state should immediately develop a moderately large construction organization fully equipped to do a portion of all classes of its work. Then in case prices on certain work are extortionate, the work may be done by force account. This plan has the advantage of developing and training the nucleus of a larger day-labor organization if one should later prove necessary. It also gives at all times a true index of the cost of various kinds of work on the basis of actual and recent state experience. We cannot know the actual cost of work unless we are actually in the construction game.

Interstate Co-operation Necessary

Every state has availed itself, I believe, of the offer of war equipment from the Federal Government. Large supplies of many things useful in highway work, especially motor trucks, have been or will be received. The organization of a proper department to receive, fit for use, and handle this equipment is no mean problem. The states should carefully consider whether this equipment should not be made the basis of building up a permanent, thoroughly well equipped day-labor organization as a means for protecting itself now and in the years to come.

I also believe it necessary for adjoining states to coöperate with a view of keeping prices for work fair and uniform under the same conditions. If adjoining states are going to bid against each other, the cost of work in all of them will be sent up to the prohibitive point, without any ultimate advantage to any state. It should be possible for the states to get together on this matter. Costs are quite figurable for each job, and with a uniform system of allowances for the use of machinery, profits, and contingencies it should be possible to put work in all states on an approximately equal basis of attractiveness. These allowances must be generous, because we must attract the best contractors, but they need not, and should not, be wasteful. This problem is the most acute of all our problems and should be given immediate and serious attention by every state. I can think of no way in which more millions can be unnecessarily spent in the next few years than by allowing unbridled and useless competition for contractors and materials to prevail between municipalities.

6. *Labor*—We speak blithely of millions of dollars for the construction of thousands of miles of road. This program means men, far more men than have ever been employed in this work before. But men are scarce, and other productive labor must not be raided. Our farms, our mines, our factories, and our mills must be allowed to produce largely and at a reasonable cost. We should not pay our labor, or allow such prices to contractors as will enable them to pay their labor, a sum per day greatly in excess of the going wage for like work in that vicinity. Whether we pay high prices for labor or whether the contractor does, it is our responsibility, because the prices we pay for work determines the

prices which can be paid for labor. In other words, we must not bull the labor market to the disadvantage of other production. This is public work, its continuance depends upon the support of the whole public, and we must be careful not to alienate this support for forcing our work at undue prices, thus upsetting local labor situations. This policy is not only right from the standpoint of expediency, but is also economically sound.

7. *Improved Location and Alignment*—We have, in the past, been too prone to build along the old-established lines of highways. This has been the easy course, and it has been taken. But the new traffic conditions are so different and so intense that in considering the construction of a main trunk highway all of the old governing considerations—such as saving the buying of new lands for right-of-way, utilizing old cuts and fills, saving an existing bridge or a few good culverts—no longer bind us to the old locations. We must connect the centers of population, because they are the points from which things and persons come and to which they wish to go. In building a modern highway between these fixed points we can feel free to exercise our untrammeled judgment and build where the road will ultimately cost the public the least. Shortness of distance, freedom from dangerous curves and from railroad grade crossings, and reasonable grades, are now the principal ends to be sought, and practically nothing else counts.

Cost of construction has become secondary. If the very conservative sum of 10c. per mile is allowed for each mile of travel saved, the saving of a mile in distance on highways carrying the following average number of vehicles per day will save the traveling public the given amount per year, which is the interest at 5% on the amount given in the third column.

VALUE OF A MILE IN HIGHWAY DISTANCE SAVED

Average Number of Vehicles per Day	Saving to Owners per Year	Saving Capitalized at 5% Equals
100	$3,650	$73,000
250	9,125	182,500
500	18,250	365,000
750	27,375	547,500
1000	36,500	730,000
2000	73,000	1,460,000
5000	182,500	3,650,000
10000	365,000	7,300,000

I believe that these figures are unassailable and that they demonstrate that when building our main highways for all the years to come, saving in distance in the layouts is the supreme consideration and should receive much more attention.

Many other important problems could be named and briefly commented on, but this paper will be too long if continued along these lines. I cannot, however, resist naming without comment some of the other things with which an efficient state highway department must also concern itself:

8. A proper system of records of the cost of all construction and of accounting for all funds available.
9. Proper publicity of plans and results, not only in the local press, but in the national press.
10. Proper care of traffic during reconstruction.
11. Proper touring maps for the information of the people of the state and of other states.
12. Proper marking of the main traveled roads, keyed to the state maps.
13. Proper accommodations for the traveling public in the way of garages, hotels, public parking places, and comfort stations.
14. Complete knowledge and study of, and, if necessary, the design of labor and time-saving devices and equipment.
15. A study of plant layouts and equipment for various types of construction under varying conditions.
16. A study of the grade-crossing situation and a strong campaign for improved conditions.
17. The holding of road schools and short courses for the instruction and inspiration of all classes engaged in supervising and constructing highways.
18. Helping to formulate and pass adequate highway legislation so that the state may keep pace with other states.

The Coming Battle

It may readily be seen from this hasty survey of some of the attendant problems that these changed highway conditions and this spirit of getting hitherto unheard of results have, instead of making our task easier, but served to increase tremendously our problems and responsibilities. We are on the threshold of a new epoch in highway construction in America, but instead of congratulating ourselves today that the long fight for highways is won, we should rather gird our loins for the impending battle. Added responsibilities bring added fears to the executive who thinks, and spur him on to new efforts and new devices for developing himself and his organization to meet the new conditions.

The coming battle is all the more serious, because from time immemorial the American people, while always willing to pay the price for the work they desire, have never been willing to pay the price of the proper supervision of it. "Millions for public works, but a pittance for those who must design and supervise the building of them," seems to be the American spirit. Our national and state legislative halls are filled with men who appropriate millions and tens of millions with very little thought of the organizations necessary to expend them properly, and with much less desire to provide proper supervision than to further the prestige of themselves or of their political party.

As a case in point: It was with the greatest difficulty that the present Congress could be induced to fix the salary of the very competent present head of the Federal Bureau of Roads at $6,000 a year, although this bureau will in the years 1919 to 1922, inclusive, supervise from the Federal standpoint and protect the Federal interest in the expenditure of probably $200,000,000 of Federal money and with it the expenditure of $300,000,000 more from the states and local units. When a Federal highway commission is proposed, to expend billions in the layout, construction, and maintenance of the proposed Federal highway system, the salaries of the commissioners and of the chief engineers are fixed, under protest, at $10,000 each per year, and we are told that Congress will never "stand for" these salaries and that they will probably be cut to much less before the bill becomes a law, if it should become a law. The national Congress is probably the most niggardly employer in America, unless some of the states bear off the unenviable palm. It seems hopeless to expect a continuously efficient organization in any Federal bureau unless Congress shall see a new light and fix public salaries to fit the imposed responsibilities.

It is interesting, although disconcerting, to note the almost total lack of interest on the part of road-promoting organizations in the fundamental problem of getting proper administrative bodies to control the highway programs. We have good-roads associations, trail associations, highway councils, etc., *ad infinitum*,

all seeking to promote the construction of roads in detail or in mass, and urging the nation, the states and the counties to spend millions or billions on highways of all kinds, classes, sorts and conditions.

The sole idea seems to be to get money, and more money, to build highways. It does not appear to matter to them what kind of highways, who builds them, or whether the people get a dollar's worth or a dime's worth for a dollar. Men are in these associations who make millions every year, who control organizations which are solely designed to get efficient dollar for dollar results, and who pay their executives what they are worth. Yet when they get into the field of public service they seemingly forget all the rules which made their own business a success, and expect a thousand-dollar man to be the eighth wonder of the world, and world-beating organizations to grow overnight; with no possible financial encouragement. Unless business men of this class wake up and devote more thought to the basic problem of getting efficient organizations to spend the money, I fear a real disaster to our highway programs.

Politics and Salaries

All of us have probably in the past derided the possibility of getting effective results out of town and county highway efforts because, we said, politics had too great a part in road work in those units and that they would never pay the salaries necessary to get competent planning and supervision of the work. And yet in 34 of the 48 states which now have state highway departments, the Governor may change the personnel of the state highway department so as to control it during his term of office. In many of these states the highway law is deliberately so framed that a new Governor may make a clean sweep of the state highway department the minute he assumes office, if he so desires. In most cases he seems to have desired it. There have been at least 127 different executive highway officials in these 34 politically organized state highway departments in the grand total of 296 years of their existence, or a change every 2⅓ years, on the average, in each state. The oldest executive officer in charge of highway work in any American state has served his state nine years in that capacity.

A state highway department is not right or it is not wrong just because it has a Republican or a Democrat at its head, or because one brand of Republican or Democrat is in control when another brand of the same political party comes into power. A state highway department is right when it is well organized to get efficient and economical results, and is wrong when it is organized or unorganized to produce inefficient and uneconomical results.

Let us consider the salaries paid the executive officers of the state highway departments. There is one who is paid $20,000 per annum; two, $10,000; one, $8000; two, $7000; two, $6000; and eight, $5000, while 32 of them are paid less than $5000, and 20 receive $3600 or less. In this connection it should be remembered that the highway work which it is expected a state highway department should supervise is now in few cases less than $3,000,000 a year and in many states it has reached, or will soon reach as much as fifteen, twenty, or twenty-five millions. What business organization in the world would pay on a similar scale for similar responsibilities or would expect to receive adequate results under such conditions?

I speak of these matters not in a spirit of fault-finding but in order to interest you in the great problem of building up public opinion to the point where, for its own protection, it will insist upon the proper organization of every agency which deals with the expenditure of these great aggregations of highway funds.

Clean-cut Efficiency

We must, by every means in our power, by precept and example, preach the doctrine of clean-cut business efficiency in American highway administration. In doing so we will go up against the age-long prejudice of the American people against paying their public servants a living or a proper wage. From top to bottom the scale of public salaries is wrong. The constitutional and other officers of the nation, of the states, of the counties, and of all other municipalities are, practically without exception, being paid, not on the basis of what their services are or should be worth, but on a basis fixed (in most cases long years ago) with due regard to the "honor" which must accrue to the holder of a public office. The universal custom was, is, and possibly always will be, to figure that the prospective holder of the job will be a politician with other interests or means and that the salary won't matter, or that joy at getting the "plum" of public office will dwarf all material considerations.

There is or should be an honor in being selected for public service—and worthy public servants appreciate and feel that honor. It may be, although I doubt it, worth while for the American people to penalize consistently those who work for them by paying them less than a living wage or less than the work would command if done for a corporation, or if done for the individual citizen in his private capacity. But the trouble with the system is that when the American people have before them a piece of really constructive work, like their present highway program, the policy falls down absolutely.

We must help the American people by making them realize that with hundreds of millions, even billions, to be expended in the next few years, the building of highways is a profession and a business and not a political football to be kicked around like the proverbial pup. This is not selfishness. Most of us are in this highway business because we love the work and because we want to help build up the states and the nation. I doubt if there is one man here who has made good or who is capable of making good who cannot leave his present state position and make more money working for himself or in employment in commercial lines. But the work must go on and it must go on well, and we must feel an interest above a mere financial interest in the jobs we hold, if we are worthy of them.

Money is not all—the satisfaction of creating, of building; of creating and building well; of helping to build a county, a state, or a nation, is worth more than a few hundred or a few thousand dollars a year if one can manage to live. We can't afford to pinch pennies and bandy words just for ourselves, but in the interest of the competent and "up and coming" highway organization which must be created in every state to protect the interests of the people of the state, we can afford to fight for the right.

Unless there appears a radical change in the American spirit of expecting much from their public servants and giving little, not one of us here will ever get rich or even attain a competence in the public service. We will, on the contrary, fight on and on until disgruntled politicians finally get us, or a younger and better qualified man supplants us. With the best of our youth, our enthusiasm and our strength gone, we will retire full of wounds, without money, and without honors to make a new start in middle age. Such is the almost inevitable fate of the servants of the American people. But we can retire with honor unsullied and with our flags still flying. Later those who now fight the good fight for right standards, and thus help make the path of their successors easy, may be recognized as public benefactors. When these pioneers are dead and buried, as is the custom here, they will be acclaimed as, after all, worth while, and possibly even monuments will be erected to some of them.

I trust that nothing I have said in regard to state highway organizations will be wrongly construed. The present organizations, with very few exceptions, are and have been doing effective work with limited opportunities. Where there is trouble it is in most cases due principally to the damnable political obsession of our American commonwealths. In too many states it is not even debated that the old political motto "to the victor belong the spoils" is the law and the gospel, and the idea that the victory of any political party or of a faction of any political party should not carry with it the transfer of all offices within the Governor's control is not even considered, but a total overturn is taken as a matter of course. County and state officials without number have been thrown out of office for no other reason than that "they have held the job long enough; someone else should be given a chance." If a bank or a railroad, or any other corporation, adopted the idea that political belief was the hallmark of efficiency, or that long-continued service was a valid reason for discharging its personnel, public confidence would be lost, its stock would be a drug on the market and the corporation itself would become bankrupt.

Well Paid Efficiency Only Basis

In fairness to my home state, Wisconsin, it should be stated that we have a nonpolitical highway commission, the operations of which have been entirely free from political interference by the Governor or anyone else. I state this because there may be some idea that my remarks originate from dissatisfaction with conditions in my own state, which is not the case. Conditions, laws and public sentiment there are good and improving fast. I have, however, long been a student of American highway administration, have followed changing state laws and personnels, and have attended practically all national highway meetings for years. As a result of these observations, I believe I can safely say that the great American highway problem will never be solved rightly until we get our state and county organizations safely established on the sole basis of well paid efficiency.

The American public must be convinced that if they will play politics with their public officials they should confine themselves to routine offices where almost anybody can "get by" because someone else does the work anyway. They must be convinced, on the other hand, that the highway departments of the states and of the counties come into a different class and that here merit and knowledge should be the sole criterion in selecting and keeping their officials, and that here at least, length of training and service is of tremendous value and a necessity if efficient and economical results are to be secured.

The professions of highway engineering and of highway building must be dignified so that they shall attract the best engineers and the best construction men in America. This is important not only for the immediate future, but especially so for the years to come. Not only must we strive to attract and keep the best we have, but we must get the coming men. We need all the brains and all the talent we can muster. To attract the best young men, good working conditions, a clean atmosphere in public service, adequate compensation and a reasonable chance of advancement must be offered. Less than this will not serve.

Therefore, let us dedicate ourselves to this work of helping to make all highway organizations efficient instruments, able and competent to carry out the American purpose of building a highway system befitting the greatness of the American nation. Than this, we can do the American people no greater service.

Purchase of Toll Bridges by New York and Pennsylvania

Active work was initiated recently by a joint commission of the States of New York and Pennsylvania for the purpose of purchasing the toll highway bridges across the Delaware River between the two states. While the subject has been under consideration since 1905, no progress was made, except for a preliminary report rendered in 1911, until authorizing legislation was passed in 1916. Commissions were named during the present year by both states, and these have now organized as a joint commission, of which Gov. W. C. Sproul of Pennsylvania is chairman, Frederick Stuart Greene, highway commissioner of New York State is vice-chairman, and E. A. Lamb is engineer-secretary. It was decided that a valuation of all the bridges and the collection of other data concerning them be undertaken at once by E. A. Lamb and Willis Whited, and that the commission then give first consideration to the purchase of the Port Jervis-Matamoras bridge, the Barryville-Shohola bridge, and the Hancock-Buckingham bridge. This work is now under way.

Eleven bridges are in question, all privately owned structures except that at Pond Eddy, N. Y., which is owned by the town of Lumberland, Sullivan County, New York. Six of the structures are steel truss bridges with plank floor (at Port Jervis, Pond Eddy, Narrowsburg, Skinner Falls, Cochecton, and Callicoon, N. Y.), the other five being suspension bridges (at Barryville and Hancock, N. Y., and at Lackawaxen, Kellam, and Equinunk, Penn.).

Some of these toll bridges have been maintained as such for about one hundred years. The Cochecton Bridge Co. was incorporated in 1817, the Narrowsburg Bridge Co. in 1823, the Chehocton Bridge Co. (Hancock, N. Y.) and the Lordville & Equinunk Bridge Co. in 1869. Two engineers are represented on the joint commission, Frank M. Williams, state engineer and surveyor, and Frederick S. Greene, state highway commissioner, New York.

Pearl Harbor Dry Dock Pump Well Large Precast Unit

Base of Concrete Box 96 by 45 Feet in Plan and 60 Feet Deep Cast on Float — Upper Part Poured in Attached Cofferdam

By R. W. Gaylord

Assistant Engineer, San Francisco Bridge Company on the Pearl Harbor Dry Dock, Honolulu, H. I.

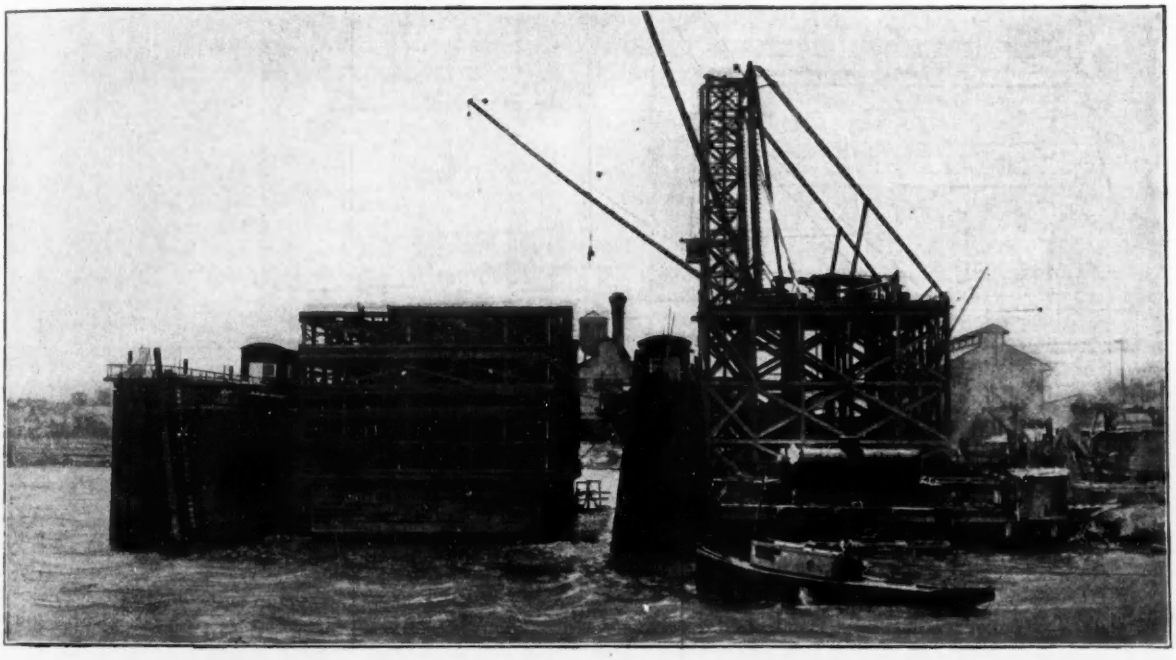
FOLLOWING the practice in the construction of the main sections of the Pearl Harbor Dry Dock at Honolulu, H. I., the large pump well of the dry dock, a concrete chamber 96½ ft. in plan, 45 ft. wide and 60½ ft. high, was precast and floated into place. As described in *Engineering News-Record* of July 25 1918, p. 173, the main sections of the dry dock were built on a temporary floating dock to a certain height, above which the walls were carried up inside a cofferdam attached to the concrete base, which by that time had been floated.

The pump well is located 6½ ft. outside of the west wall at the entrance end of the dock, and rests on a combined pile and crushed-rock foundation 52½ ft. below low water. The floor is 3 ft. thick and the sidewalls 5½ ft. at the bottom tapering to 3 ft. at the top. A longitudinal wall extending to the top of the pump well separates the pump compartments from the suction and discharge culverts. Four cross-walls extending to within 22½ ft. of the top act as struts to carry the pressure of the water and backfill through the compartments, in which are located four 54-in. and two 15-in. vertical centrifugal pumps capable of unwatering the dock in slightly less than two hours. Steel beams set in the walls above the pumps carry the 6-in. concrete floor and the motors. They also act as struts for that part of the wall above the cross-walls.

Three 6 x 6-ft. emptying conduits lead from the floor of the dock under the west side wall into a suction culvert 7 ft. 3 in. x 10 ft., which extends the entire length of the pump well with a 3 ft. 3 in. roof separating it from the discharge culvert. Set in the concrete wall of the suction culvert are four 54-in. flared pipe castings and one 22-in. pipe to which the pumps are connected; 9 ft. 9 in. above these castings are four similar ones through which the 54-in. pumps discharge, the 15-in. pumps discharging through a 22-in. pipe in the end wall.

As shown on the drawing, the discharge water must pass up and over the cross-walls which extend through the discharge culvert. This culvert extends the length of the pump well, with an opening to the sea 12 x 15 ft. protected by five sliding screens.

For filling the dock, there are three 4½ x 6-ft. conduits leading from the discharge culvert through the walls of the pump well and dock. These openings are controlled by electric-driven gate valves.



PRECAST PUMP WELL IN FLOATING DRY DOCK JUST BEFORE LAUNCHING

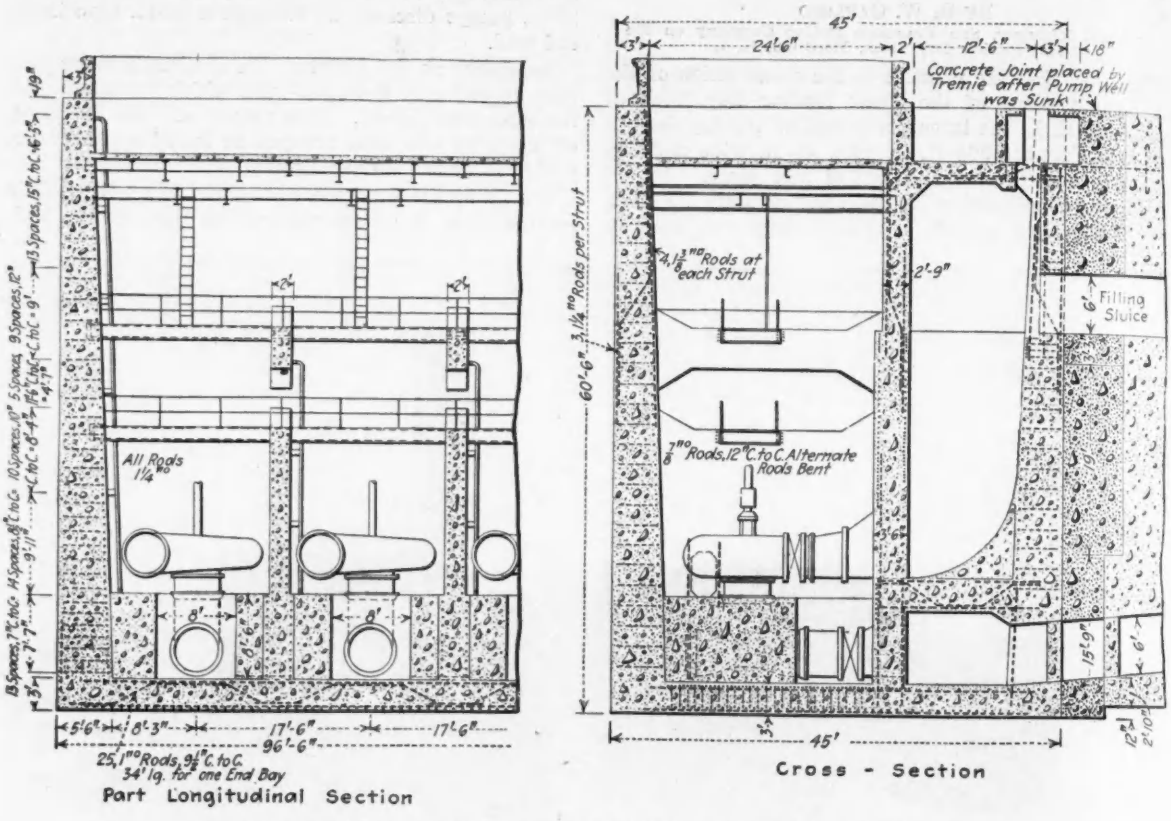
The pump well is located 6½ ft. from the dock, to give clearance for handling to place. This space is filled with concrete, forms being first placed for filling and emptying conduits.

The site for the pump well was dredged to a depth of 53½ ft. below low water. Wooden piles were driven on about 4-ft. centers and cut off 53 ft. below low water by means of a circular saw suspended from a floating piledriver. A 12-in. layer of 2½-in. rock was then spread around and over the tops of the piles and leveled by means of a heavy steel drag to within 0.1 ft., plus or minus, of theoretical grade.

The excess weight of the walls near the bottom made it impossible to erect a part of the structure on shore or on a floating dock and, after launching, to sink the same as the walls were poured. Therefore it was necessary to add a wooden crib to increase the height of a section of the pump well so it would float. The crib was built to a sufficient height so that in case the structure filled with water and sank, 4½ ft. would still be above

water. This would have been of great assistance in salvaging.

The first 18 ft. of the pump well were poured on the 3500-ton floating dock which had been used in connection with the construction of the 16 pontoon sections of the dry dock. As shown on the drawing, the regular section of the pump well was built with the addition of a concrete shoulder along one side and the two ends and brackets on the other side. These were constructive features added to make provision for anchoring the sheathing of the crib to the concrete section. Six by 12-in. timbers on edge were bolted 6 in. from the outer edge of the shoulder, and a concrete backing was poured behind these timbers. On the side where the brackets are, built-up timbers were bolted, providing a bearing for the sheathing at the same distance from the wall of the pump well as on the other side and ends.



DETAILS OF CONCRETE PUMP WELL FOR PEARL HARBOR DRY DOCK

The inside dimensions of the crib were: Width, 48 ft. 8 in., length 100 ft. 2 in.. and height 40 ft. The bracing consisted of five courses of 12 x 12-in. combined timber and concrete struts, with supporting posts between courses. The concrete sections were placed where the struts ran through the walls of the pump well, and made it unnecessary to stop the pouring of the walls at any particular place to remove struts. A sixth course of all-wood struts was erected to be used as a working deck and was removed when the walls reached that height. The walings were made up of 12 x 22-in. timbers as shown in the drawing; 6-in. sheathing in 40-ft. lengths took bearing on these walings.

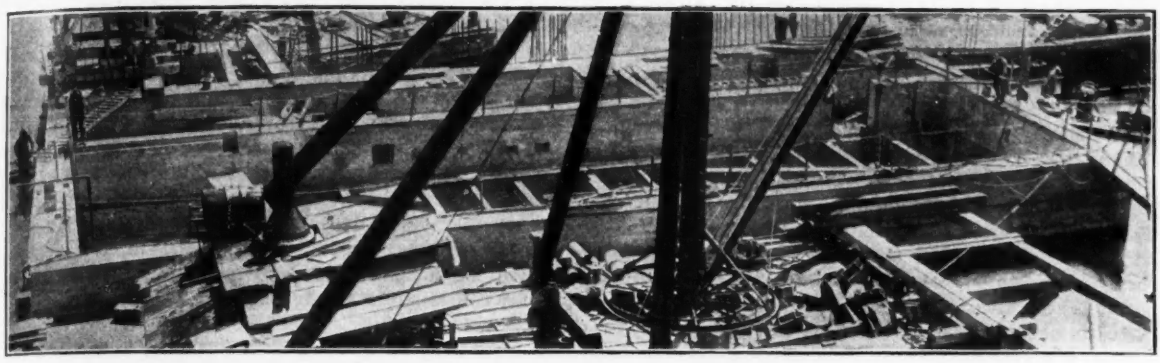
The six courses of struts with the vertical and horizontal cross-bracing were first erected. The sheathing, which had previously been bolted together in 4-ft. widths with spun-yarn calking between, was swung into place and fastened top and bottom by 6 x 12-in girts, as shown on the drawing. This sheathing was also held in place by tie-wires, from end to end and side to side, fastened on the outside to 6 x 12-in. girts. The joints between sections of the sheathing were calked and pitched in place.

The combined concrete and timber structure, drawing 28 ft. of water, was floated off the floating dock and anchored over its final location. The concrete walls were then poured in 5-ft. courses. Water ballast had to be added at times to keep an even trim, since the line of the center of gravity did not coincide with the center of the structure.

Drainage back of the walls was provided for by pipes cast in the concrete near the top of the 18 ft. concrete section. These were later plugged on the outside by a diver and filled with concrete and capped from the inside.

The concrete is a 1:2:3½ mixture made up of two parts of crusher dust to one part of river sand brought from Puget Sound and 1-in. rock. Only a few small leaks were found, and those were easily stopped from the inside by drilling 6-in. holes into the concrete where the leaks were and driving in small pipes. These were grouted up around the outside to force the water through the pipes and, when the grout had set, the pipes were plugged.

Practically all the construction was done while the structure was afloat. This prohibited taking levels by ordinary methods. The form on the floating dock for

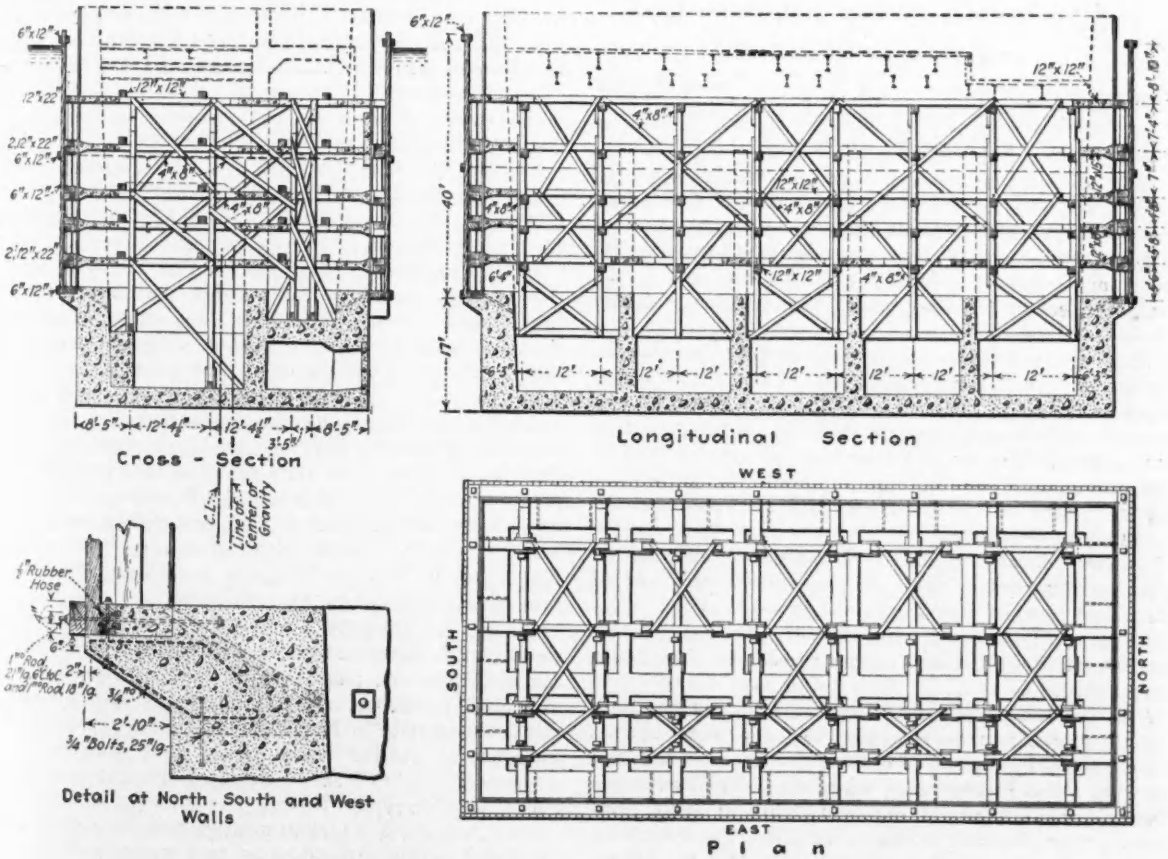


CONCRETE PUMP WELL SUNK IN ITS FINAL POSITION

the bottom of the pump well was practically one plane. An engineer's level was set up, the height of instrument measured from a point on the floor directly below the level, and elevations 3 ft. 3 in. above the form were established on three bolts. Any slight uneveness of the floor was taken care of, so the marks on the three bolts were in the same plane. Other bolts were then set and marked to act as checks. With the plane fixed, a level could be set up at any time, brought into the plane of three marks, and elevations set where needed. This plane was carried up as the walls were poured. Points on brackets fastened to the walls at the same elevations and at definite distances from the outside of the walls were used for locations and for keeping the work perpendicular to the floor.

As temporary bulkheads, precast concrete slabs were set in the emptying conduits and also in the filling conduits. The former came into use as soon as the structure was floated, and the latter when the crib was removed. A timber shutter was also placed over the discharge culvert opening, since all parts of the pump well had to be kept dry for some time after the crib was removed.

The removal of the sheathing and walings was done by divers. To facilitate the removal of the walings, $\frac{3}{4}$-in. rods were fastened to the concrete shoulder of the first 18-ft. section. These rods extended up through the bottom course of walings. Rods were fastened through this bottom waling to the one above, and so on up. In removing the walings, the rods between



GENERAL OUTLINES OF CONCRETE PUMP WELL WITH COFFERDAM SUPERSTRUCTURE

the top two courses were first taken out, leaving only one course loose at a time. This arrangement made it much safer for the divers and prevented the walings from floating up in a jam.

The concrete between the pump well and the dock was poured through a tremie pipe in five courses. The brackets described before, which were constructed on the dock side of the pump well, were for the purpose of allowing clearance for the tremie pipe to reach the bottom of the space between the dock and the pump well. Forms made up of bags of concrete placed by divers made pockets about 16 ft. long and 10 ft. high. This proved to be a very cheap method of constructing forms, especially as all pockets in a course could be poured without removing forms.

There were 1733 cu.yd. of concrete in the section of the pump well poured on the floating dock, and the crib contained 240,000 ft. b.m. of timber. The total weight of the combined structure as erected on the floating dock was 8,200,000 lb. The pump well complete contains 4500 cu.yd. of concrete, 250,000 lb. of reinforcement and 97,000 lb. of structural steel.

The pump well was designed by the Bureau of Yards and Docks of the Navy and erected by the San Francisco Bridge Co., which has the contract for the dry dock complete with pump well. Commander George A. McKay, public-works officer for the Pearl Harbor Navy Yard, is in charge for the Navy, and Francis B. Smith is chief engineer in charge of the work for the San Francisco Bridge Company.

Safety Engineering Reduces Cost of Construction

Statistics of Expenses and Savings From Actual Construction Operations Show Economy of Accident Prevention

ACCIDENT prevention has proved highly profitable in the construction operations of the E. I. du Pont de Nemours Co. General statistics of expenses and savings due to accident prevention on two of these operations are given in a paper by F. L. Hurlbutt, safety engineer, before the construction section of the National Safety Council.

Early in 1918 the company undertook its largest construction project, the complete design and erection of a smokeless-powder plant for the United States Government. An average working force of 25,000 men was maintained. Shortly after the start of construction in March, the safety engineer began building up his organization, which had by the latter part of April assumed working proportions.

During March and April, the period of organization for the department, the "lost-time rate" expressed in days had steadily increased until it stood at 2.27 days lost per man per year. By May 31, one month after safety activities had been begun in earnest, this figure was reduced to 1.28, the next month saw it lowered to 0.744, the following month it stood still, but the next month saw a further reduction to 0.684, then came a drop to 0.351. In the next 30 days occurred the only upward trend in the curve, when the figure went from 0.351 to 0.441, really an excellent figure in itself. But again, with the last month of activity, the downward tendency was resumed, with the result that the lowest figure of all was attained—namely, 0.216.

In the seven months of the safety department's activities the lost-time rate had been reduced from 2.27 to 0.216, a 90% reduction, which is regarded as a truly remarkable record, when it is considered that it was made in the face of a very high labor turnover and with a working force almost entirely new to the company. The total frequency rate, calculated on the annual basis after the Federal practice, was 58.9. The fatality frequency rate, calculated on the same basis, was 1.0.

When this project was first conceived, a rate was quoted the company for carrying liability insurance on all the construction employes. Using this rate, the cost of insurance against injuries, both fatal and nonfatal, to the company, would have been $452,752 as against the actual cost of $66,101, a saving of $386,651. Deduct from this the cost of maintaining the safety department, $50,000, and a net saving of $336,651 is seen.

On the construction of a large shell-loading plant, where similar safety efforts were carried out by the company, though on a scale not quite as large, equally impressive figures are available. Here the success of the safety work resulted in the actual cost of injuries being $5733, as against a figure of $103,545, if liability insurance had been carried with an outside firm. This gives a saving of $97,812, from which the cost of maintaining the safety department, $10,500, must be deducted, giving a net saving of $87,312. Here the total frequency rate was 47.8 and the fatality frequency rate was zero.

In May, 1916, during a temporary lapse in construction activities in his particular line, one of the company's best construction engineers was made safety engineer on one of its largest plants, where an average operating force of 12,000 men and a construction force of 700 men was then maintained. For two years he acted in this capacity, and became a real convert to the safety cause. When construction work was started on the Government powder plant, this individual was made a division engineer in charge of the "Miscellaneous Division," which comprised a force of from 2500 to 2800 men. This was exactly the opening he wanted—an opportunity to practice as an engineer on construction what he for two years had been preaching to other construction engineers. Were his preachings vindicated? His record will answer that question. From Mar. 16, 1918, to Sept. 1, 1918, his working force of 2500 to 2800 men had but one major injury.

To many, the examples cited may seem to be of so unusual a character, and the work carried on under such abnormal conditions, that it is not fair to use the results obtained therefrom in arriving at a decision whether safety work pays on construction. To allay such doubts, let the accident-prevention work and safety campaign, with the excellent results attained, which has been carried on during the construction of a large chemical plant these past eight months, be considered.

On this job the effectiveness of the safety work was shown in the difference between the actual costs, including compensation, plant-hospital maintenance, doctor's salaries and the cost of maintaining the safety department, amounting to $8695 for seven months, and the premium of $16,768 which would have been paid on employees' liability insurance carried outside—a net saving of $8073 for the period. An average annual frequency rate of 100.1 and an average severity rate of 0.5, calculated on the Federal basis, was maintained for the first eight months of the work.

Baltimore's Paving Recorded by Map and File System

Complete Data of Even the Oldest Pavements Are Being Compiled—Special Colored Maps and Supplementary Card System Used

By R. Keith Compton
Chairman and Consulting Engineer, Baltimore Paving Commission

COMPLETE record of all paving laid in the City of Baltimore, Md., is being made by means of a map and file system. The types of paving are indicated by various colors on the maps, while the details are kept on cards. The system makes it possible to obtain, in a short time, complete information regarding the paving on any street in the city.

Public street paving of Baltimore previous to 1905 was done entirely under the jurisdiction of the city engineer, now known as the highways engineer. Since that date the paving has been done under the jurisdiction of several agencies: The Annex Improvement Commission, whose work is confined to a belt annexed to the old city in 1888, and which is operating under a special tax scheme; the State Roads Commission, paving streets selected by the city authorities from an apportionment of state roads funds; the Highways Engineer, who frequently handles new paving under special appropriations and who handles the paving of all private alleys, and, finally, the Paving Commission, authorized under an act of the legislature passed in 1906 and amended in 1908. The last-named body can exercise jurisdiction over the entire city, but has confined itself so far to the old section as it existed up to the year 1888. However, no matter which agency does the paving, the funds accruing therefrom under the paving tax accure to the amount of the Paving Commission and are expended by that body.

In addition to the agencies outlined above, private streets are improved either by the abutting owners or by building contractors, and the record of these streets is also included in those compiled by the Paving Commission.

Previous to 1913, the records were compiled and maintained by the city engineer, and consisted of maps in atlas form, on 200-ft.-scale mile-square sheets. On these sheets were indicated, by conventional colors, the various kinds of paving only. No other records were kept except the usual construction drawings, and we had to refer to annual reports of the particular department which had jurisdiction over the paving. While the records of some departments were very much in detail and accurate, the information contained in those of other departments was more or less obscure and inaccurate in detail. Accurate paving records of new and old work are absolutely necessary, and, in order to secure this information and make it available for quick reference, the Paving Commission has assumed jurisdiction over the compilation and maintenance of these records.

On the 200-ft.-scale mile-square sheets, the various classes of paving are indicated by the conventional colors. On each section of work, the limits being marked by arrow points, is placed a small paster, in-

INTERMEDIATE LENGTHS AND WIDTHS OF STREET

FROM	TO	Width Feet	Length Feet
E.B.L. Shields Place	W.B.L. Druid Hill Ave.	38.63	1378.40
E.B.L. Druid Hill Ave.	W.B.L. Linden Ave.	38.69	1245.60
E.B.L. Richmond St.	W.B.L. Park Ave.	36.50	599.60
E.B.L. Park Ave.	W.B.L. Brevard St.	37.50	153.70

DISTRIBUTION OF RETURNS AT INTERSECTIONS

STREET RETURN	Side of Street	Kind of Paving	Kind of Base	Width Feet	Length Feet
Pine St	N.S.	V.B.	6" Conc.	11.7	13.4
			" "		13.15
Argyle Ave.	N.S.	S.A.	" "	36.4	13.15
Alley east of Argyle Ave.	N.S.	V.B.	" "	12.2	13.60
Wilmer Alley	N.S.	"	" "	12.0	13.0
	S.S.	"	" "	14.6	13.1
Penna. Ave.	N.S.	S.A.	" "	38.3	14.7
	S.S.	" "	" "	36.4	12.6
Pear St.	N.S.	V.B.	" "	12.6	13.5
Tesier St.					
	S.S.	S.A.	" "	23.7	14.0
Alley west of Druid Hill Ave.	N.S.	V.B.	" "	5.8	15.0
Alder Alley					
	S.S.	V.B.	" "	6.5	13.4
Alley east Druid Hill Ave.	S.S.	V.B.	" "	11.8	13.5
McCulloh Ave.	N.S.	S.A.	" "	34.9	13.6
	S.S.	" "	" "	39.1	14.3
Alley east of McCulloh St.	N.S.	V.B.	" "	11.2	13.3
	S.S.	" "	" "	10.9	13.6
Madison Ave.	N.S.	S.A.	" "	38.9	14.45
	S.S.	" "	" "	39.1	11.85
Alley east of Madison Ave.	N.S.	V.B.	" "	12.0	13.40
	S.S.	" "	" "	9.9	13.20
Eutaw Place	N.S.	S.A.	" "	38.4	13.85
	S.S.	" "	" "	104.6	13.60
Alley east of Eutaw Place	N.S.	V.B.	" "	11.9	12.70
	S.S.				
Brexton Alley					
	S.S.	V.B.	" "	10.0	14.20
Bolton St.	N.S.	S.A.	" "	39.9	13.20

Record of Paving Laid by the Paving Commission

Biddle St. from E.B.L. Shields Place to W.B.L. Brevard St. Contract No. 103

Contractor Balto. Asphalt Block & Tile Co. Engineer in Charge H. D. Williams Jr.

Length of Street 3377.80 Feet. .64 Miles. .51 Miles Average 30 Ft. Wide. Width of Street 37.78 Feet 9029.81 Sq. Yds.

Length of Returns 335.80 Feet. .07 Miles. .33 Miles Average 30 Ft. Wide. Railway 5760.75 Sq. Yds.

Name of Material Used	Kind of Paving	Wearing Surface or Filler	Binder or Cushion	Base	Area	Sq. Yds.	Unit Price
Montezuma	Sheet Asphalt	1½" Topo	1½" Binder	6" Conc	City	7905.35	1.83
" "	" "	"	"	"	Ry.	736.81	1.83
Woodstock	Granite Block	Cement	¾" Sand	"	City	11.11	3.45
" "	" " Sawed	Bituminous	" Mortar	"	Ry.	452.28	4.40
Mack	Vit. Block Gutter	Cement	" "	"	City	837.12	2.20
Woodstock	Granite Block	"	¾" Sand	"	Ry.	3840.82	3.45
Mack	Vitrified Block	"	" Mortar	"	Ry.	680.89	2.27
"	" "	"	" "	"	City	278.23	2.25

Date of Contract: 2-6-15
Date of Starting: 5-11-15
Date of Completion: 7-20-15
Working Days Consumed: on Contract 103
Date Guaranty Expires: 9-29-20
Date Assigned Appeal Tax Court: 8-2-15
Date Assigned City Eng's Dept. 10-7-15

Other Prices: A.C.C. 57¢ Grading City 75¢
Grading Ry. - 90¢
Remarks:
Prev. Paving - Cobble 13038.56 S.yds.
" " Asphalt Block 1092.00 " "
" " Granite Block 660.00 " "

dicating the department in charge of the work, the contract number, the date of completion and general reference to the details of the paving. These sheets are mounted on heavy cardboard filed vertically as swinging leaves in a metal filing cabinet, and immediate reference may be had to any section of the file by swinging back the leaves.

The color scheme used on the maps is as follows: Asphalt block, orange; bitulithic, dark green; bituminous concrete, purple, cement concrete, gray, granite block on concrete base, greenish blue; granite block on sand, blue crayon pencil hatched; macadam, light blue; scoria block, pink; sheet asphalt, light brown; vitrified brick, red, and wood block, yellow..

Further records, filed in drawers in the lower portion of the map case, are made on 5 x 8-in. cards, and give all details of the construction, such as the paving agency, the contract number, the length and the total area of work, details of contract, the beginning and completion of work, the quantities of the various items of the work with the unit prices, the various brands of paving material and the previous paving of the area. Reproductions of the data cards are shown. The tables of intermediate lengths and widths of street and street returns are on the back of the paving record card. On the maps details are shown of even some of the oldest paving in the city, notably Eutaw Place, paved in 1883. The data on this old paving were obtained by reference to the annual reports for that year. In all cases where such reports did not give this information someone familiar with the paving was consulted for such details and, failing in this, a physical examination was made of the actual paving. With reference to work done by private parties and builders, if this was done under the jurisdiction of the city, the records were accessible; if not, it was simply a matter of "digging for it." Since 1914 the records have been recorded as rapidly as the construction has been executed.

Previous to 1918 the area of Baltimore was 31.5 square miles, and the paving records so far cover this area. In 1918 approximately 60 square miles were added, which addition included many small towns and villages all containing various kinds of improved paving. These records will be extended this autumn and winter so as to include the paving in the new addition, and the same procedure will be followed; that is, reference to annual reports of town and county engineers, the county commissioners seeking, where necessary, personal interviews with those who have knowledge of the construction and physical examination of the streets.

New Type of Wood and Asphalt Flooring for Chicago Bridges

Transverse Planks on Edge Form Surface Grooves to Hold Asphalt Surfacing—Light Weight and Low Cost

By F. H. Avery
Engineer of Bridge Construction and Repair, Department of Public Works, Chicago

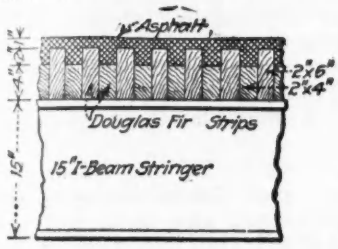
A LIGHT-WEIGHT combination wood and asphalt paving for bridges has been developed in Chicago, owing to the high cost of wood and the advantages of this material where weight is a prime factor, especially in the case of bascule bridges. Its cost is materially lower than that of the ordinary wood floor.

Flooring for the Chicago River bridges consisted originally of a wearing surface of 3 x 12-in. oak plank on 4 x 6-in. yellow-pine planks spaced 12 in. on centers and laid diagonally across the steel stringers. This form of construction was changed to 6 x 12-in. yellow-pine planking laid solid at right angles to the stringers and carrying 4-in. hexagonal blocks, all material being creosoted. In cold weather this flooring afforded poor footing, and caused congestion of traffic. This defect is so serious that its elimination was considered to warrant the use of a pavement more expensive in both first

LAYING PLANKS FOR WOOD AND ASPHALT DECK OF CHICAGO BRIDGE

cost and maintenance. The new floor, however, gives better footing and lower cost.

An experiment was made with short sections of pavement built up of 2 x 4-in. and 2 x 6-in. strips placed alternately and nailed together, the slots or grooves thus formed being filled with asphalt containing different percentages and sizes of emery. With an iron block placed at one end and the section tipped until sliding started, it was found that "angles of repose" could be obtained much greater than that given by sandstone blocks, and accordingly this method was used in reflooring the Van Buren St. bascule bridge. That floor has been in service about six months, but, though it gives a great increase in tractive effort, it wears too rapidly on the exposed side grain of the 2 x 6-in. strips.



PLANKS FORM CORRUGATED DECK FOR ASPHALT SURFACE

The filling in the slots was composed of 100 lb. of asphalt mastic, 50 lb. of sand and about 20 lb. of No. 14 emery, making a very hard material. The wood was thoroughly mopped with hot asphalt flux, and then the filler was rammed into the slots. The flooring was built up in the field, the strips being nailed to each other with 20-d. nails spaced about 1 ft. on centers and then face bolted with ¾-in. bolts spaced 4 ft. on centers along the bridge and about 5 ft. transversely. It is important to have plenty of these bolts and to pull them up tight before asphalting, as any springing of the floor in cold weather will crack the filler. The bolts are placed in the grooves so as to cover them with asphalt. Vertical bolts through the flanges of the stringers anchor the wood deck in place.

For similar flooring on the Clark St. swing bridge the emery was omitted and regulation sheet asphalt was used, as furnished by the Bureau of Streets. This surfacing was laid, however, for a thickness of 1½ in. over the top of the 6-in. strips, and granite chips were rolled in by a five-ton roller. The floor has been in service three months and has proved satisfactory. It prevents the accumulation of dirt between the subplank and nailing strips, whereas when the old floor was torn out more than 40 tons of this dirt was removed. It is waterproof to a remarkable extent, so that its use on bascule bridges is expected to avoid the present annual expense of taking off counterweight in dry weather and adding it in rainy seasons. On the other hand, it is feared that in extremely hot weather the asphalt may soften to so great an extent as to allow the deflection to become uncomfortably noticeable. However, if this occurs the floor will be wetted by hose from a hydrant during such hot spells.

The mixture used on the Clark St. bridge was composed of 10.9% of bitumen, 13.3% of 200-mesh stone dust, 18% of 80-mesh, 48.4% of 40-mesh and 9.4% of 10-mesh. This was rammed by hot irons about 1 ft. long and 1 in. thick, which were drawn along the slot by a handle and struck with sledges in order to give as dense a filler as possible. The granite chips were rolled in, but this was not satisfactory for the Erie St. bascule bridge, as the raising of the bridge allowed all the excess stone to roll off, while traffic had been relied upon to drive this down into the asphalt. The sheet asphalt cost 9c. per square foot, delivered hot on the floor and 23c. for labor to lay, or a total of 32c. For the next work it is planned to use the following mix: Bitumen, 8.5%; cement, 9.5%; stone (from ½-in. down to No. 10 mesh) 25%; sand, 57%. This will do away with the top dressing and the trouble due to rolling off of the stone. To secure a good bond between the wood and asphalt the strips were surfaced on one side and edge so as to give a rough surface.

When this type of floor was first discussed, no attempt was made to figure its strength or stiffness, as there was no way of guessing how the asphalt and wood would act under load. On the Erie St. bascule bridge the wood strips were laid directly across steel stringers about 2 ft. 8 in. apart, this span being much greater than any previously employed in this construction. When an asphalt truck weighing about nine tons was backed out to unload, the deflection of the bare wooden strips was such that the wheels were kept over the stringers for fear of breaking through. After the asphalt surfacing was completed, a coal motor truck weighing 28,380 lb. went over at about 12 miles per hour, and the deflection was hardly noticeable.

This floor almost eliminates vibration, which with the old plank flooring caused continual expense for replacing light bulbs and renailing loose plank. It is free from the danger of fires caused by cigar stumps igniting the dry road dust and manure lying along the curb. At times these fires got so great a hold on the road plank and subplank as to require the fire department to put them out, but the fire now burns out on top of the granite chips and does no harm.

When one of these floors has been in service a year we shall know how heat and cold affect the asphalt, but changing floors in 75 bridges at a cost of from $12,000 to $15,000 each entails much responsibility, so helpful suggestions or criticisms will be welcome. As to cost, the new type is much cheaper than 6-in. creosoted plank and 4-in. creosoted blocks. For the latter the material alone costs $1.20 per square foot and, allowing nothing for labor, this is 50% more than the new type costs in place. The cost per square foot for flooring the Erie St. bridge was 82c., divided as follows: Eight cents for carpenter, at $1 per hour; 1c. for carpenter foreman, at $8.50 per day; 3c. for bolts in place, at 60c. per bolt; 38c. for select Douglas fir lumber, at $54 per 1000 ft. bm.; 32c. for asphalt in place, including material and labor. The new type weighs 15 lb. per square foot for lumber and 14 lb. for asphalt, or 29 lb. (figuring 3 lb. per board foot for fir and 110 lb. per cubic foot for asphalt). This compares with 43 lb. for the old type.

This floor design was worked out by the writer and O. W. Hansen, under direction of T. G. Pihlfeldt, city bridge engineer, and P. S. Combs, now city engineer.

Sand and Gravel Produced in 1918

According to reports received from the United States Geological Survey, 2800 producers showed an output of 61,824,426 short tons of sand and gravel in 1918. Although this production was 14,894,899 tons less than that of 1917, the average price per ton was 15c. higher, making the 1918 output worth $37,927,079, an increase over 1917 of $2,630,147. The production of sand used in building and for paving work amounted to 22,409,029 short tons, 2,722,144 short tons being used for paving.

A Diagram Adaptation of the Rational Method of Storm-Water Drain Design

Review of Maps, Population Estimates, Rainfall Intensities, Probability Charts and Various Instruments and Methods Associated With Storm-Sewer Design, and Illustration of How Diagram Is Used

By Harold G. McGee
Hydraulic and Sanitary Engineer, Des Moines, Iowa

TO INSURE accuracy, and yet simplify and expedite storm-water drain and combined sewer computations sufficiently to permit the routine determination of the costs of comparative designs, the following scheme of application of the rational method has been developed. Equipment, supplies and operations listed on the accompanying instruction card (Table I.) are described below:

TABLE I. INSTRUCTION CARD: STORM-SEWER DESIGN COMPUTATIONS

Equipment and Supplies

Topographic map	Design diagram
Development map	Computa tion form.
Planimeter	Straight-edge
Scale	Pencils, black and re.
Slide rule	Ink and lettering pens

Operation	No. of Units	Unit	Unit Time, Min.	Total Time, Min.
1. Get out equipment	.....	.....	.....	5.00
2. Sketch watersheds	.....	Section	1.00	.....
3. Lay out sewer lines	.....	Section	3.00	.....
4. Planimeter watershed's	.....	Section	2.00	.....
5. Compute quantity, size, grade	.....	Section	9.30	.....
6. Check computations	.....	Section	6.60	.....
7. Ink computations	.....	Section	4.50	.....
8. Replace equipment	.....	.....	.....	10.00
Total productive time	.....	.....	.....	.....
Allowance for lost time, interruptions, rest, etc., 30%	.....	.....	.....	.....
Total time allowed	.....	.....	.....	.....

Topographic Map.—The most effective uses of a topographic map in sewer design require it to be on such a scale and contour interval as will indicate: (1) Drainage areas and subareas down to one block; (2) elevations of low spots within blocks which must be drained; (3) elevations of block corners and other manhole points, and (4) the extent of drainage areas above the district to be served.

An excellent map for this purpose, in country that is not unusually rough, has a 1-ft. interval and a scale of 1 in. to 200 ft., of which the plane-table sheets for Dayton, Ohio, Jackson, Mich., and portions of Lucas County, Ohio, topographic surveys are representative. An ordinary street map in which watersheds are sketched by field inspection, with the occasional aid of a hand level, and with block corner elevations transferred from available profiles or from preliminary reconnaisance, has served well; but when drainage areas extend beyond districts well marked by streets or are bounded by very flat apex marshes, such maps have proven misleading. While the economies to be effected in topographic mapping are not always applied, methods of mapping are known well enough not to require explanations here.

Development Map—The development map is simply a picture of the city to be, its probable residential, industrial, commercial, park, railroad and waste areas, their populations, their values and their degrees of imperviousness. Such a map is an essential requirement for economical and effective drainage plans. Obviously, the densely built-up and impervious commercial areas at one extreme will contribute more water per acre, and suffer more costly damage from insufficient drainage facilities, than the grassy areas of parks and cemeteries at the other. An analytical study of past changes in and growth of population, industries, various classes of residential districts, railroads, and general land values, gives a more reasonable and scientific basis for such plans than the not unusual mere guesses or absolute neglect of everything beyond existing developments.

Information for such studies has been obtained as follows: For population, from federal and state census, directories, school census, also death, postoffice, telephone, and gas and electric companies' records; concerning industries, from field inspections, conferences with realty operators, transportation, and Sanborn maps; concerning commercial areas, same as for industries; for land values, from assessed valuations per front foot and for totals for city, from conference with realty operators and from transportation facilities; concerning imperviousness, from field inspections, Sanborn maps.

Each of these factors varies with, although not always as, the others. Relations for individual cases, however, become somewhat readily apparent; and having projected population by the usual methods, the probable coincident values of the other factors can be determined and checked with some degree of reason. Based on one such study, a realty company for which the writer was asked to prepare plans for immediate sewer construction abandoned a considerable subdivision project which seemed not to be in an economical direction for expansion of a prosperous, growing city.

Population studies are based on the usual growth curves, determined by past enumerations and extended along the lines of other and larger cities with comparable locations and development factors. At Jackson, Mich., the location of population was determined by plotting each name in the directory in its proper block and then multiplying by a factor to obtain the total population of the block. This factor was determined by comparison of directory and census, for census years, and varied as follows, showing no apparent relation to the factors offered in the directories themselves:

TABLE II. COMPARISON OF CENSUS ENUMERATION AND NAMES IN DIRECTORY

Year	Census Enumeration	Names in Directory	Ratio	Ratio Given in Directory
1890	20,798	10,503	1.942:1	2.75:1
1900	25,180	14,472	1.783:1	2.25:1
1910	31,438	12,738	1.715:1	2.50:1

The number of names in the directory was obtained by counting every eleventh page, adding these figures together, and multiplying by eleven. For one directory this method was checked by counting all names as well, resulting as follows:

TABLE III. COMPARISON OF DIRECTORY ESTIMATES AND COUNTS

Estimated number of names by counting every eleventh page	29,800
Actual count of names	29,363
Error	1.8%

A rodman who knew the city was used to spot the directory locations for each name, and he averaged 900 persons or names per eight-hour day. The location

of directory names being known, the determination of densities requires simply a multiplication by the determined directory factor, and dividing the result by given block areas. Once the densities for several decades have been established and rates of growth or decay determined, field inspections and conferences with utility and realty operators permit density predictions with some show of reason.

Sanborn maps, census statistics, and field measurements, are available as aids to the determination of the extent of impervious areas. Results of an investigation of eleven residential blocks by the latter method are shown in Table IV. Because of the usual insufficiency of roof gutters on ordinary houses, only two-thirds of the roof area was considered as comprising impervious area for sewer design; and sidewalks, house walks, with grass on each side, detached barn and shed roofs without gutters were added as one-third of their area.

TABLE IV. PROPORTION OF IMPERVIOUS AREAS IN RESIDENTIAL BLOCKS; MEASUREMENTS IN JACKSON, MICH., 1917

	SW-85	NE-3	R-8	M-	E-13	NE-2	NE-14	E-16	E-11	E-15	NE-4
1. Block numbers											
2. Area, acres	7.52	5.00	5.00	5.00	7.08	5.00	6.40	5.15	7.69	5.79	5.00
3. Population, persons	96	77	86	93	165	127	175	155	240	187	96
4. Density, persons	12.8	15.4	17.2	18.6	23.3	25.4	27.3	30.1	31.2	32.3	1.92
5. Impervious area, acres	2.636	1.732	1.370	1.376	2.248	1.648	2.078	1.588	2.455	1.241	1.705
6. Impervious area, per cent. of total	35.0	34.6	27.4	27.5	31.8	32.9	32.5	30.8	31.9	30.1	34.1
7. Street surface, acres	0.709	0.546	0.546	0.546	0.734	0.546	0.728	0.607	0.803	0.676	0.546
8. Alley surface, acres	0.099	0.307				0.307					0.307
9. Sidewalk surface, acres	0.272	0.209	0.209	0.209	0.277	0.209	0.257	0.216	0.298	0.237	0.209
10. Roofs, direct to sewer, acres	0.196	0.021			0.272		0.094				0.023
11. Roofs, cistern to sewer, acres	0.250			0.033	0.041		0.110	0.0602	0.200	0.034	0.065
12. Roofs, cistern to ground, acres	0.367	0.343	0.353	0.310	0.564	0.382	0.418	0.414	0.580	0.398	0.308
13. Roofs and housewalks to ground, acres	0.743	0.306	0.262	0.278	0.360	0.204	0.471	0.291	0.584	0.396	0.247
14. Impervious area for sewerage, $(7+8)+\frac{1}{3}(9+13)+\frac{2}{3}(10+11+12)$, acres	1.688	1.268	0.938	0.938	1.53	1.246	1.387	1.092	1.497	1.175	1.268
15. Percent of total	22.4	25.4	18.8	18.8	21.6	24.9	21.7	21.2	19.5	19.3	25.4

Average percent impervious without alleys, 20.1.
Average percent, impervious with alleys, 24.5.

Planimeter—In spite of its utility, many offices do not possess a planimeter; and for the past three years such instruments have been scarce and high-priced. As a substitute, good results can be obtained from the "hatchet" planimeter, consisting essentially of a knife-edge with a point in the same plane, described in McCullough's "Practical Surveying," p. 50. Naturally cheaper, it is more portable and less liable to breakage than the Swiss instruments. Its use requires more time than the use of the usual instrument, however, due to the necessity for repetitive checks.

Slide Rule and Scale—An ordinary 10-in. slide rule and a white-edged scale to fit the scale of the topographic map meet the requirements of these two items.

Design Diagram—Planned to eliminate unnecessary multiplications and the use of a series of flow diagrams or tables, the accompanying diagram (Fig. 1) gives the essential features of run-off, capacity, grade, size, velocity head, and time of flow through each section,

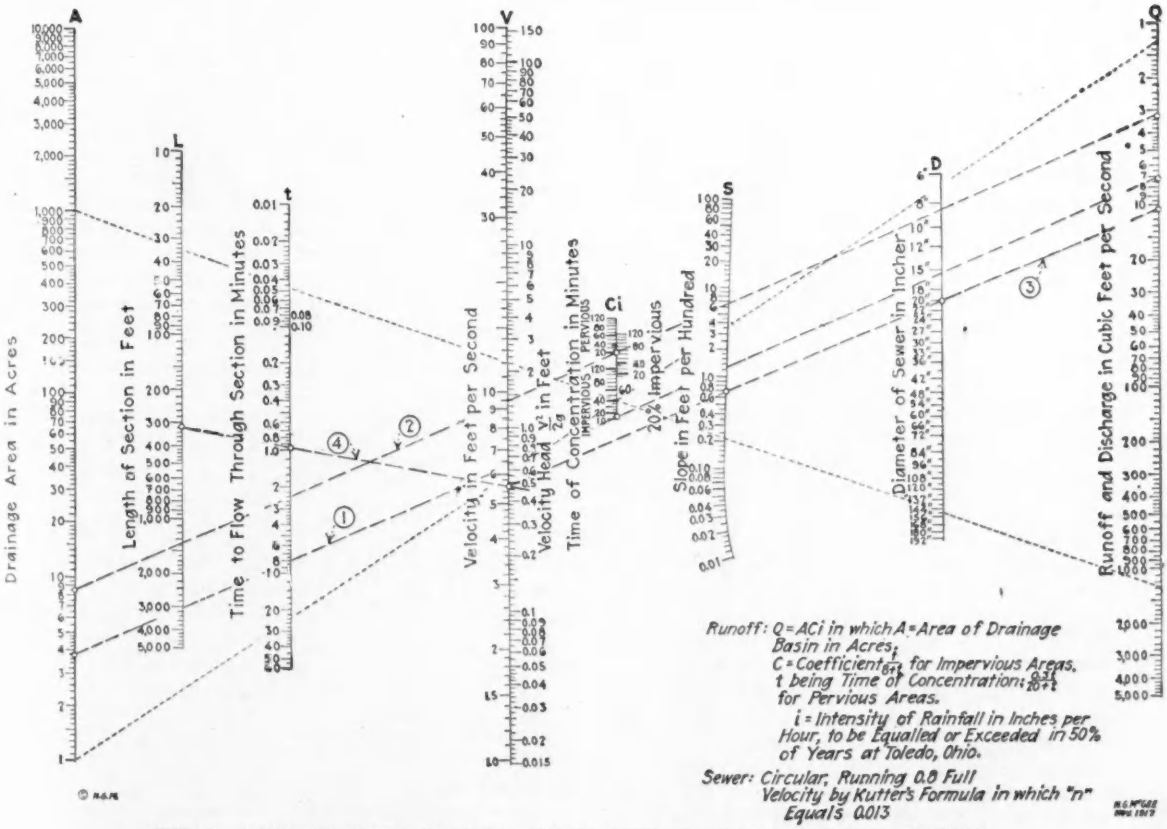

A
Drainage Area in Acres
L
Length of Section in Feet
t
Time to Flow Through Section in Minutes
V
Velocity in Feet per Second
Velocity Head $\frac{V^2}{2g}$ in Feet
Ci
Time of Concentration in Minutes
IMPERVIOUS
PERVIOUS
20% Impervious
S
Slope in Feet per Hundred
D
Diameter of Sewer in Inches
Q
Runoff and Discharge in Cubic Feet per Second
Runoff: Q=ACi in which A=Area of Drainage Basin in Acres; C=Coefficient, $\frac{t}{4+t}$ for Impervious Areas, t being Time of Concentration; $\frac{0.3t}{20+t}$ for Pervious Areas.
i=Intensity of Rainfall in Inches per Hour, to be Equalled or Exceeded in 50% of Years at Toledo, Ohio.
Sewer: Circular, Running 0.8 Full Velocity by Kutter's Formula in which "n" Equals 0.013

FIG. 1. DIAGRAM FOR DESIGNING STORM SEWERS BY THE RATIONAL METHOD

with three or four settings of the straight-edge. It is based on the usual rational formula, $Q = ACi$, and has but three scales subject to change for any combination of rainfall intensities, run-off coefficients and velocity coefficients of channels. The method of preparing this type of chart is described by R. C. Strachan, in "Nomographic Solutions for Formulas of Various Types," *Trans.* Am. Soc. C. E., Vol. LXXVIII., 1915, p. 1359.

If sewers are to be designed as economic structures, they must be built for less frequent gorging in high-value, congested districts, than in open residential or park areas. For this reason, the following analysis of the *Ci* factor was used:

Run-off Coefficient—A series of values of the run-off coefficient *C*, developed by several engineers, with a few points computed from published gagings, are shown on Fig. 2. For the sample chart, Curves I and III were

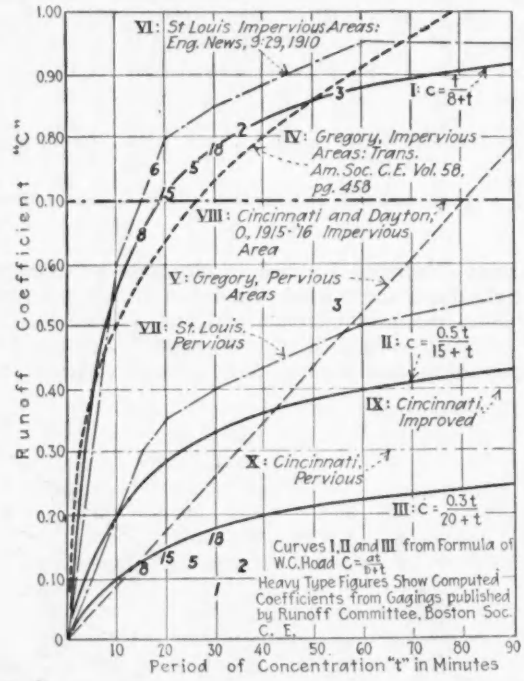

VI: St Louis Impervious Areas: Eng. News, 3-29, 1910
I: C = t/8+t
IV: Gregory, Impervious Areas: Trans. Am. Soc. C.E. Vol. 58, pg. 458
VIII: Cincinnati and Dayton, O, 1915-16 Impervious Area
V: Gregory, Pervious Areas
VII: St. Louis, Pervious
II: C = 0.5t/15+t
IX: Cincinnati, Improved
X: Cincinnati, Pervious
III: C = 0.3t/20+t
Curves I, II and III from Formula of W.C. Hoad C = at/b+t
Heavy Type Figures Show Computed Coefficients from Gagings published by Runoff Committee, Boston Soc. C. E.
Runoff Coefficient "C"
Period of Concentration "t" in Minutes

FIG. 2. COMPARISON OF RUN-OFF COEFFICIENTS FOR STORM-SEWER DESIGN

used for impervious areas and pervious areas, respectively.

Intensity of Rainfall—Rainfall intensities to be expected at various frequencies, were found as follows:

Table V is an abstract of Weather Bureau records showing maximum intensities for different short-time intervals at Toledo, Ohio. From these maxima, during the fourteen years of record, the probability chart, Fig. 3, was constructed according to the procedure described by Allan Hazen in "Storage To Be Provided in Impounding Reservoirs," *Trans.* Am. Soc. C. E., Vol. LXXVII, page 1539; and, from this probability chart, Table VI was prepared to show rates which may be expected to be equalled or exceeded during the maximum storm occurring in periods of from 2 to 20 years. Table VI is the basis of Fig. 4, showing the same expected storm intensities with some slight irregularities ironed out by a smooth logarithmic curve, Fig. 4, as a basis of design, will result in a series of sewer capacities which, it may reasonably be expected, will be ex-

TABLE V. MAXIMUM PRECIPITATIONS FOR SHORT-TIME INTERVALS AT TOLEDO, OHIO, 1903-1916, IN INCHES

Year	5-Min.	10-Min.	15-Min.	30-Min.	60-Min.	120-Min.
1903	0.38	0.54	0.62	0.77	1.19	1.61
1904	0.41	0.59	0.65	0.84	1.07	1.02
1905	0.35	0.66	0.77	0.77	0.78	1.12
1906	0.27	0.44	0.55	0.83	1.11	1.44
1907	0.52	0.72	0.81	1.04	1.22	1.25
1908	0.46	0.72	0.88	1.19	1.64	1.80
1909	0.54	0.91	1.08	1.38	1.52	1.63
1910	0.34	0.49	0.61	0.68	0.89	1.04
1911	0.45	0.80	1.02	1.89	2.14	2.24
1912	0.35	0.57	0.66	0.89	1.01	1.02
1913	0.37	0.54	0.60	0.83	0.95	1.20
1914	0.47	0.74	0.91	0.96	1.34	1.47
1915	0.45	0.70	0.75	0.76	0.82	1.07
1916	0.23	0.34	0.36	0.51	0.53	0.73

TABLE V. PRECIPITATION IN INCHES PER HOUR TO BE EQUALED OR EXCEEDED ONCE IN FROM 2 TO 20 YEARS

Period	5-Min.	10-Min.	15-Min.	30-Min.	60-Min.	120-Min.
2 years	4.80	3.77	2.93	1.60	0.98	0.60
3 years	5.26	4.15	3.30	1.90	1.20	0.72
5 years	5.74	4.50	3.60	2.30	1.40	0.80
10 years	6.21	4.92	3.94	2.87	1.68	0.91
20 years	6.64	5.25	4.24	3.45	1.96	1.09

ceeded at approximately predetermined frequencies.

Determining the unit run-off, *Ci*, for any frequency of intensity requires but a simple multiplication of the intensity for the given period of concentration by the run-off coefficient for the same time. Any such point

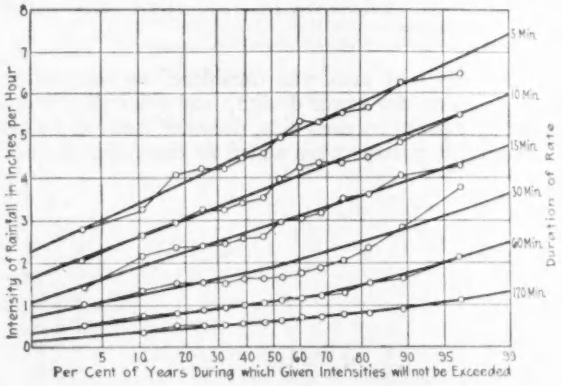


FIG. 3. PROBABILITY CHART FOR RAINFALL INTENSITIES

is located on the chart by a simple intersection and marked with the time of concentration it represents. For example: The 40-minute intensity of a two-year storm—that is, one to be equalled or exceeded once in two years—is 1.52 in. per hour; the run-off factor for

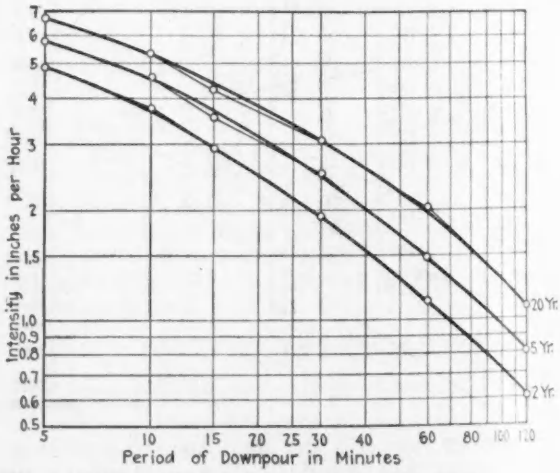


FIG. 4. EXPECTED STORM INTENSITIES

a 100% impervious area is 0.833; the resultant run-off is 1.27 sec.-ft. per acre; and the scheme of location of this particular point on the diagram is indicated. The 20% impervious scale is obtained by adding 0.2 of the run-off from one impervious acre to 0.8 of that from one pervious acre.

Ci Probability Direct—An examination of excessive precipitation records reveals the fact that excessive rates, particularly for intervals less than about 30 min., do not necessarily appear in the first period of the

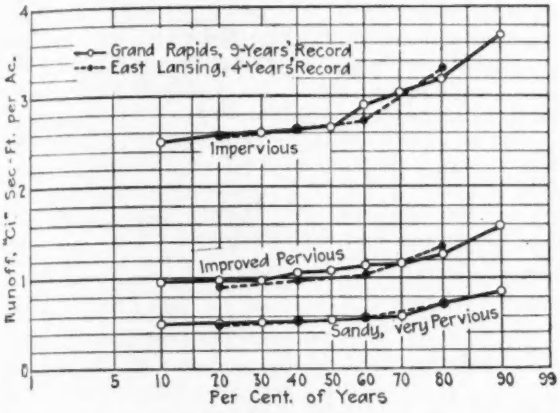


FIG. 5. PROBABLE FREQUENCIES OF FIVE-MINUTE RUN-OFFS AT GRAND RAPIDS AND EAST LANSING, MICHIGAN

downpour. Run-off coefficients increasing with the time of concentration may, therefore, be low for areas having a quick run-off. The short-time coefficients used at Dayton and Cincinnati allow for this fact. On the other hand, longer excessive rates—that is, for from 30 to 120 min.—nearly always commence near the beginning of the downpour, a fact which the variable coefficient formulas recognize. It is believed, then, that a run-off coefficient based on the total amount of precipitation prior to the excessive rate would, therefore, be more exact than either. Incidentally, discharge being a product of two variables, intensity and percentage of immediate run-off, the chances are that a probability curve derived from the consideration of both intensity for any concentration period and the run-off conditions as evidenced by the preceding rainfall would more nearly approach conditions which might be expected to recur. A comparison of three such probability curves for Grand Rapids and East Lansing, Mich., using a run-off coefficient, K, based on curves I, II, and III, Fig. 2, multiplied by the intensity curve $I=1.75\frac{80}{t+20}$ with which these curves have been developed is shown on Fig. 5. While for so short a time interval as to be useless for sewer design, these curves indicate three significant things:

1. That the run-off for short-time intensities is not as low as the variable coefficient curves of Fig. 2 indicate;

2. That excessive run-offs may occur with comparatively moderate intensities late in a storm, and

3. That consideration of a second variable in run-off decreases the number of years of record necessary to obtain a reasonably good estimate of the frequency with which certain run-offs may be expected.

Capacity, Size and Velocity—Circular sections running 0.8 full, the point of maximum velocity and minimum time of concentration, were used as the basis of the capacity, Q, size, D, slope, S, and velocity, V scales. The relations between Q, D, and V are geometric, since $A=0.6736\ D^2$, *and* $Q=AV$. These scales are, therefore, logarithmic. But, using Kutter's coefficient for the Chezy velocity formula, S bears a varying relation with D and V. The location of the S-scale was determined as follows: For a given slope, V was computed for a range of sizes, 12-, 24-, 48-, 96-, and 192-in. Lines were drawn connecting the chosen sizes and the computed velocities; these lines failed to intersect at a point; so, after neglecting the effect of very large sizes on steep slopes and very small sizes on flat slopes, the center of gravity of the significant intersections was chosen as the point to represent the given slope.

These points, determined in multiples of 10, were connected, giving a canted scale with curved lower end, and the intermediate points were located by logarithmic subdivision. A test of this scale, with the sizes and slopes originally computed, indicated an average excess of velocity of 1.08% (—3.0% to +9.3%) over that found by exact computation. A similar test of a 20-in. slide rule designed to solve the same problem, and which was in use in the office prior to the construction of the diagram, indicated an average excess of about 8.5% (+3.7 to +16.7%) over the same range.

STORM WATER DRAIN DESIGN
SAMPLE COMPUTATION
DESCRIPTION ..... ASSUMPTIONS: See Combined Topographic and Development Map (Fig. 1) Diagram Design 2 Year Surcharging Period; Kutter's "n" = 0.013

SHEET ..... OF ..... JOB NO. ..... FILE NO. .....
DESIGN BY ..... DATE .....
CHECKED BY ..... DATE .....
APPROVED BY ..... DATE .....
DRAWING .....

LINE	STREET	FROM	MANHOLE	TO	MANHOLE	STORM WATER RUNOFF: AREA IN ACRES: TOTAL	PER CENT IMPERVIOUS	IMPERVIOUS	PERVIOUS	TIME OF CONCENTN: t	CU. FT. PER SEC.: TOTAL	FROM IMPERVIOUS	FROM PERVIOUS	TOTAL	SEWER: DISTANCE BETW MANHOLES	SURFACE ELEV.: UPPER END	LOWER END	FLOW LINE ELEV.: UPPER END	LOWER END	FALL IN FEET	SLOPE	SIZE	INVERT ELEV.: UPPER END	LOWER END	CAPACITY	VELOCITY: FT. PER SEC.	HEAD	CURVES: Δ	R	HEAD LOSS	LINE
1	Merriman	Wall	1	½ Blk N	10	4.76	225	1.07	3.69	0.4	15	2.1	1.5	3.6	140	963.1	961.1	958.00	956.04	1.96	1.40	12	957.20	955.24	3.7	5.5	0.48	0			1
2	"	½ Blk N of Wall	W	Damon	2	2.16	40	.86	1.30																						2
3						6.92		1.93	4.99	0.5	15.4	3.7	1.9	5.6	160	961.1	962.0	956.04	954.48	1.60	1.00	15	955.04	953.44	5.7	5.5	0.48	0			3
4	Damon	1st Alley E of Merr.	3	Merriman	2	3.89	30	1.17	2.72		15	2.2	1.1	3.2	165	958.0	962.0	955.00	952.50	2.50	1.30	15	952.00	951.50	3.2	3.0	0.14	36R	2	0.51	4
5	Merriman	Damon	2	High	4	1.39	45	.62	.77																						5
6						12.20		3.12	8.48	1.0	15.9	7.1	3.2	10.3	330	962.0	960.7	951.49	949.18	2.31	0.70	20	950.16	947.85	10.6	5.6	0.48				6
7	High	160' E of Merr.	5	Merriman	4	1.93	40	.077	1.16		15	1.5	0.44	1.94	160	959.2	960.7	954.20	953.56	0.64	0.40	12	953.40	952.76	2.0	3.0	1.4	36R			7
8	Merriman	High	4	Stanley	6	1.94	50	.097	.097																						8
9						16.01		5.46	10.61	0.7	16.9	10.0	4.0	14.0	320	960.7	950.8	948.76	944.60	4.16	1.30	20	947.45	943.29	14.4	7.6	0.90				9
37																															37
38																															38

FIG. 6. SAMPLE COMPUTATION SHEET FOR STORM-SEWER DESIGN

Time to Flow Through Section—Having given the velocity in feet per second, the time in minutes to flow from end to end of the section requires the construction of two simple logarithmic scales, as shown.

Computation Form—As an aid to complete, orderly and systematic records of design calculations, the accompanying computation sheet (Fig. 6) was prepared. Of the three divisions of this sheet, the "location" columns are similar to many others; the "storm-water run-off" sections are somewhat simplified for the diagram design; and the "sewer" columns appear somewhat more complicated than usual, as they provide for basing designs on the water surface rather than the invert elevations. Printed on thin paper or vandyke paper these computation sheets can be blueprinted to turn over to draftsman or attached to reports.

Straight-Edge or Isopleth—For a straight-edge, or isopleth, a 12-in. celluloid triangle, with a straight line scratched along one side and used on the diagram scratch side down, avoids parallax and does not obscure figures on one side, as do ordinary opaque straight-edges.

The accompanying example illustrates the operations required in the instruction card. For the sake of simplicity only one diagram, for a two-year gorging period, for storm-water only, has been used throughout.

Sketch Watersheds—With a detailed topographic map, Fig. 7, the picking out of watershed limits requires simply a following out of ridge lines. The subareas may be divided as shown or split down the center of each block, without affecting materially the sewer capacities required.

Layout Sewer Lines—Once the watersheds are laid out, the logical locations for drains are usually apparent. If not, all alternative locations ought to be studied to determine which is best.

Planimeter Watersheds—The records of watershed measurements are made on the map, within each watershed.

Compute Quantity, Size, Grade, Etc.—Records of computations for a drain are shown on the accompanying computation sheet, Fig. 6.

The positions of the isopleth for computing line 5 of the sample computation sheet are indicated on the diagram as follows:

Position 1. Set isopleth on Scale A at 3.72 acres and on Scale Ci at 15.9 min. for impervious area; under this line, extended to Scale Q, read 7.1 sec.-ft. run-off from impervious area.

Position 2. Set isopleth on Scale A at 8.48 acres and on Scale Ci at 15.9 min. for pervious area; under this line, extended to Scale Q, read 3.2 sec.-ft. run-off from pervious area. Add run-off from pervious and from impervious areas: 7.1 + 3.2 = 10.3 second-feet.

Position 3. Set isopleth on Scale D at 20 in. and on Scale S at 0.7%, under this line, extended to scale Q, read 10.6 sec.-ft. capacity; and, under this line, extended to Scale V, read 5.6 sec.-ft. velocity and 0.48 ft. velocity head.

Position 4. Set isopleth on Scale V at 5.6 sec.-ft. and on Scale L at 32.0 ft.; on this line, at Scale T, read 1.0 min. to flow through section.

Acknowledgments—This opportunity is taken to acknowledge the courtesy of F. F. Longley, of Hazen, Whipple & Fuller, in supplying sheets of probability paper, and of W. C. Hoad in permitting the publication of his run-off formula.

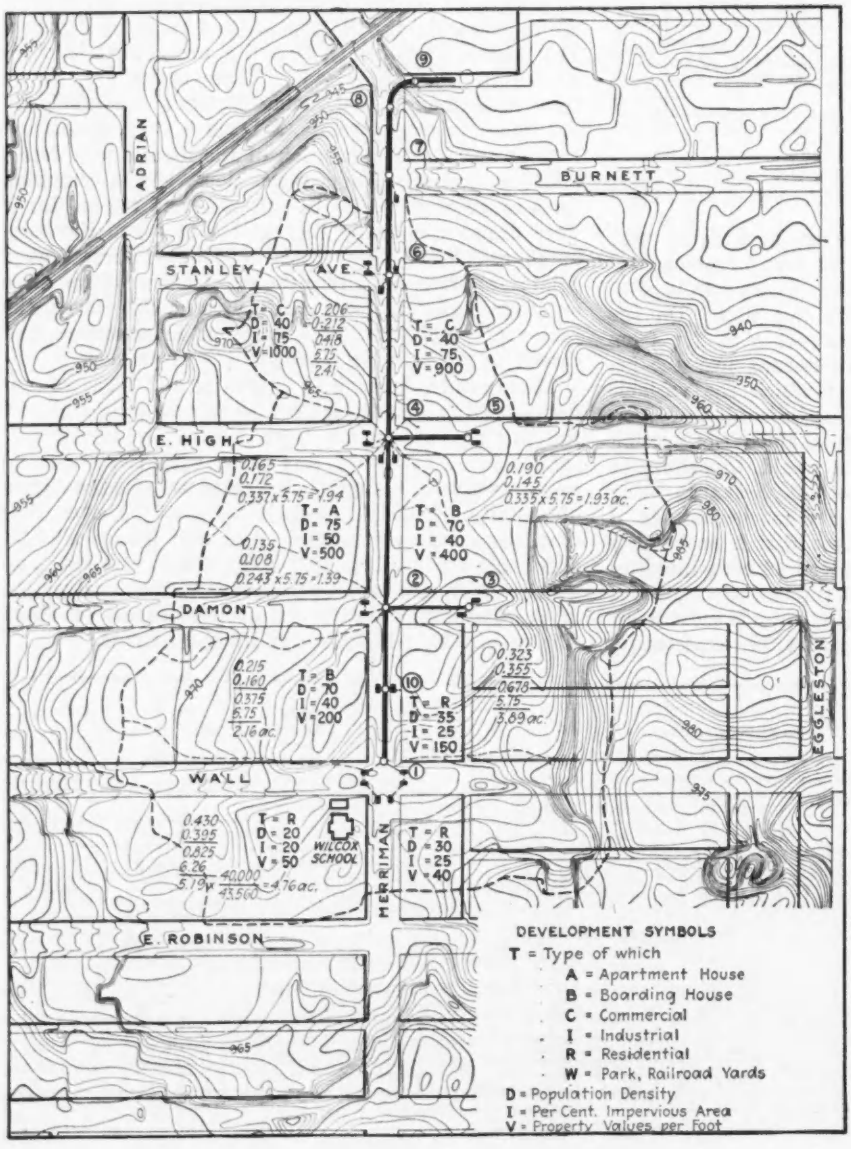


FIG. 7. COMBINED TOPOGRAPHIC AND DEVELOPMENT MAP

Floodgates Proposed for Control of Savannah River

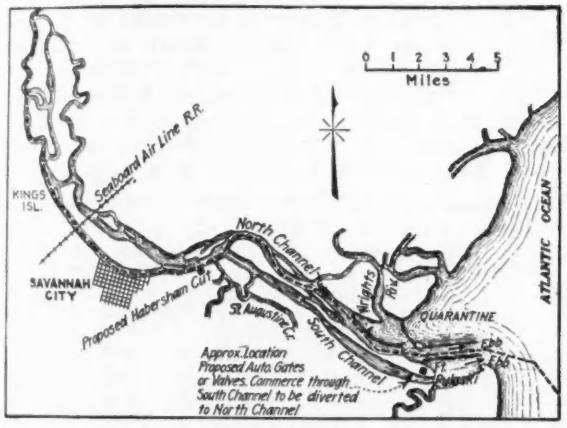
Movable Dam at Mouth of Unused Channel Would Permit Concentration of Ebb To Scour the Main Ship Channel

By E. C. Garvin

Brunswick, Ga., formerly Assistant Engineer, United States Engineer Department, Savannah, Ga.

CHANNEL control in the Savannah River is becoming an important problem. For that reason there is submitted here a proposed solution of the difficulties; it differs in detail from that now officially proposed.

Savannah Harbor comprises the lower 20 miles of the Savannah River estuary and the improved channel across the knoll, the roads and the bar. The river is heavily silt-bearing. Throughout the lower 30 miles there are two main branches formed by a series of islands of alluvial formation. The right branch above Savannah and the left branch below the city are under improvement for navigation. The harbor has three project



CHANNEL CONDITIONS AT MOUTH OF SAVANNAH RIVER, BELOW SAVANNAH, GA.

depths: Thirty feet from the sea to Quarantine, a distance of 10½ mi.; thence 26 ft. to the Seaboard Air Line railway bridge, a distance of 15½ miles; thence 21 ft. to Kings Island, a distance of 1½ mi. These depths refer to mean low water. The mean tidal range varies from 6.5 ft. on the bar to 6.0 ft. at Kings Island. The width of the improved branch, as defined by the banks or the regulating works, varies from 600 ft. at Savannah to 1800 ft. at the mouth of the river.

Prior to improvement, the channel was in places not more than 9 ft. deep at mean low water. Since improvement, material increase in depth has been obtained in part by the use of contraction works and closing dams, and in part by dredging. The contraction works have been gradually extended in elevation to high water, and in plan to the mouth of the river. The closing dams have forced a larger part of the flow into the main channel. In order to secure the greater depth provided in each new project, increasing reliance has been placed on dredging.

On account of the jetties at the mouth of the river, probably little if any material is now carried into the estuary by the littoral drift. Judging from the character of the material dredged, the amount rolled along the bed of the estuary may be as much as 20% of the total deposit. From data concerning the Savannah River at Augusta, collected by the Geological Survey, it is estimated that the total amount of matter carried annually in suspension and solution into the lower reaches of the river is 7,500,000 cu.yd. (Augusta is 201 miles by river above Savannah.) Annual hydrographic surveys of the harbor have been made for a number of years. These show a persistent tendency to fill at some localities and occasionally to scour at others.

The surveys show that about 8% of the annual shoaling occurs between the upper limit of the improvement and the upper mouth of South Channel, about 51% between the latter point and the mouth of the river, and about 41% from here to deep water beyond the bar. As applied to Savannah Harbor, the rate of shoaling seems to bear some relation to the mean channel depth or cross-sectional area of flow, which may be expressed most easily in terms of cubic yards of material remaining to be removed to accomplish specific project dimensions. The annual shoaling has increased so enormously in recent years, as the 26-ft. project approaches completion, that the economical removal of this deposit is causing some concern. Each additional foot of depth costs more to obtain and to maintain than the preceding foot. Savannah Harbor offers ideal conditions for a control of tidal and fresh water flow.

Tidal observations indicate (1) that the improvement of the harbor has had little or no effect on the mean height of the high-water plane: (2) that the gradual extension of the dredging up stream has depressed the mean low-water plane in proportion to the distance from the mouth of the river at which place the mean low-water plane is unaffected; (3) that the volume of fresh-water flow affects both the high-water and low-water planes, the latter to a greater extent than the former.

In 1889 Assistant Engineer Gieseler made elaborate tidal investigations of Savannah harbor. The data then obtained are here (Table I) (see next page) modified to conform more closely to present conditions, so it is to be understood they are only approximate. Synchronous mean tidal curves at Fort Jackson and Fort Pulaski show that the maximum difference in elevation of the water surface at the two gages is 1.82 ft., which remains constant for a period of 55 min. (1 hour 35 min. to 40 min. before low water at Fort Pulaski or 2 hours 55 min. to 2 hours before low water at Fort Jackson).

The present plan of improvement of Savannah Harbor provides for a closing dam in South Channel apparently above St. Augustine Creek, for it further provides for a cut connecting Habersham Creek with Savannah River in the vicinity of Fort Jackson for the purpose of maintaining the continuity of the inside waterway which would be interrupted by the closing dam in South Channel. This dam is to be of the rock-fill type. Its purpose is to prevent the fresh-water flow from entering South Channel and to force it into the main North Channel, thus strengthening the ebb flow and inducing scour.

On both the ebb and flood tides certain volumes of water now pass through South Channel and St. Augustine Creek without contributing in any way to the improvement of the harbor below Fort Jackson. The rock-filled closing dam would prevent the escape of any proportion of the fresh-water flow into these auxiliary channels and would thus promote the improvement and maintenance of the dredged channel below the dam, but this structure would offer an effective barrier to the flood-tide flow of South Channel and St. Augustine Creek which it is desired to capture and divert to the

North Channel on the ebb tide. Under conditions of a solid dam, the ebb, flood and fresh-water flow would be confined to the North Channel and the tidal prism above Fort Jackson reduced by the amount that previously passed through South Channel and St. Augustine Creek. This would be a violation of the cardinal principle governing the improvement of estuaries, that the tidal prism shall not be obstructed in flow and shall not be diminished in volume.

Therefore the writer proposes to substitute for Habersham Cut and the solid dam at the upper end of South Channel a restricted cross-section for St. Augustine Creek which will conform to the proposed dimensions of Habersham Cut, and at the lower end of South Channel a movable dam of the ordinary automatic floodgate type or a more elaborate mechanically operated structure which will freely admit the flood flow and prevent the escape of the ebb. By this means the flow lost to St. Augustine Creek would approximate the loss which would result from the opening of Habersham Cut, and the troublesome subjects of free right of way, new railway bridge, and division of land would be eliminated. The total volume of flood flow entering South Channel and a proportion of the flood entering St. Augustine Creek would be captured and forced to escape through North Channel, increasing the ebb flow by an amount exceeding half the mean fresh-water discharge, and this increase would be applied to that portion of the harbor in which more than 50% of the annual shoaling occurs.

Comparison of Various Railroad Bills

THE comparison of railroad bills now before Congress, shown on the opposite page, reproduced from a chart prepared by the Equitable Trust Co. of New York, readily displays the practical unanimity of opinion in Congress as regards ownership, the broadening of Federal control, and the desirability of effecting mergers into large operating units. All but the Sims bill, representing the so-called Plumb plan of the railroad brotherhoods, provide for private ownership; all provide for the broadening of Federal control, and all but one make various provision for mergers of present operating units. There is wide divergence in the provisions for ratemaking, finances and distribution of earnings.

area of flow with a consequent decrease in shoaling and increase in depth, the latter two being the prime objects of harbor improvement. The cross-section of North Channel is ample to receive the increased ebb volume resulting from this improvement without affecting the stability of the banks or the existing regulating works.

It is not proposed to provide for navigation past the automatic gates. South Channel is now used but very little for navigation, having a 5-ft. controlling depth.

The general principle here outlined may be readily applied to the reaches above Savannah where the pondage area and tidal range are relatively large, but it would seem advisable to proceed with some caution,

TABLE I. VARIATION IN WATER PLANE DUE TO RIVER IMPROVEMENT

	Water Works, Savannah			Savannah River, Augusta City Gage*	Fort Jackson (Five Miles Below Water Works)			Fort Pulaski (Eleven Miles Below Fort Jackson)		
Year	Mean High-Water	Mean Low-Water	Mean Range		Mean High-Water	Mean Low-Water	Mean Range	Mean High-Water	Mean Low-Water	Mean Range
1878	....	....	....	7.3	7.25	0.85	6.40	....	....	
1889 } 1890 }	7.18	2.00	5.18	9.6	7.05	0.59	6.46	6.75	0.00	6.75
1894 } 1895 }	7.01	2.20	4.81	9.0	6.89	0.88	6.01	6.63	0.00	6.63
1903	7.12	1.57	5.55	11.1	7.20	1.19	6.01	6.78	0.14	6.64
1904	6.93	1.00	5.93	7.8	7.03	0.71	6.32	6.82	0.05	6.77
1905	....	....	....	8.9	7.18	0.70	6.48	6.78	0.07	6.71
1906	7.34	1.51	5.83	12.0	7.27	0.80	6.47	6.87	0.08	6.79
1907	7.13	1.16	5.97	9.2	6.81	0.82	5.99	6.74	0.01	6.73
1908	7.31	1.89	5.42	11.6	7.13	0.87	6.26	6.77	0.17	6.60
1909	7.25	1.60	5.65	11.6	7.24	1.03	6.21	6.83	0.27	6.56
1910	7.08	1.12	5.96	9.8	6.87	0.65	6.22	6.55	0.17	6.38
1911	7.04	0.94	6.10	8.9	6.94	0.59	6.35	6.46	0.15	6.31
1912	7.51	1.48	6.03	12.9	7.07	0.79	6.28	6.79	0.20	6.59
1913	7.05	0.91	6.14	10.6	6.93	0.71	6.22	6.63	0.17	6.46
1914	7.06	0.62	6.44	9.1	6.91	0.58	6.33	6.53	0.01	6.52
1915	7.28	1.03	6.25	11.3	7.12	0.85	6.27	6.77	0.31	6.46
1916	7.22	0.91	6.31	10.4	7.03	0.71	6.32	6.66	0.05	6.61
Mean 1903-1916	7.18	1.21	5.97	....	7.05	0.79	6.26	6.71	0.13	6.58

* Add 110.8 ft. to reduce to height above Pulaski mean low water. Augusta is 201 mil. by water above Savannah.

The exact effect of this improvement cannot be predicted; probably the low-water plane would be slightly raised, possibly the duration of the ebb tide would be increased and the period of slack water correspondingly decreased; certainly, the voulme of ebb flow in the improved channel would be increased, which would be reflected in an adjustment between increased velocity and owing to the fact that the main channel is somewhat narrow and any large increase in velocity might necessitate bank revetment to prevent undue widening. The effect of the South Channel automatic dam should be well determined from systematic observations, after which the extension of the system may proceed with a degree of certainty not warranted now.

TABLE II. TIDAL RANGES IN SAVANNAH RIVER

Locality	Mean Cross-Sectional Area of Flow, Sq.Ft.	Mean Ebb Velocity Ft. per Sec.	Duration of Ebb Flow, Hours-Min.	Mean Flood Velocity, Ft. per Sec.	Mean Flood Duration, Hours-Min.	Mean Ebb Flow (Tidal and Fresh Water), Cu.Ft.	Mean Flood Flow, Cu.Ft
Wrights River	....	....	....	....	....	250,000,000	210,000,000
Maine channel at Fort Pulaski	49,000	1.72	6-39	1.15	5-46	2,000,000,000	1,230,000,000
South channel at Fort Pulaski	....	....	....	....	....	800,000,000	460,000,000
Fort Jackson	30,000	1.80	7-12	1.40	5-13	1,400,000,000	790,000,000
South channe just below St. Augustine Creek	....	....	....	....	....	350,000,000	160,000,000
St. Augustine Creek	10,000	1.61	6-20	1.22	6-05	365,000,000	265,000,000

NOTE.—(South Channel: Length 50,500 ft., mean width 1,360 ft., area 68,700 sq.ft.). The total ebb flow of the harbor is increased by the accumulation of half a lunar day's fresh-water flow, amounting to about 610,000,000 cu.ft., which enters both North Channel and South Channel, a portion of the latter flow passing into St. Augustine Creek.

RAILROAD BILLS NOW BEFORE CONGRESS

FEATURES OF PLANS	THE ESCH-POMERENE BILL *Interstate Commerce Commission Plan* NUMBER OF BILL: H. R. 4378—S. 1256 DATE INTRODUCED: JUNE 2, 1919	THE SIMMS BILL *Railroad Brotherhoods or Plumb Plan* [INTRODUCED BY REQUEST] NUMBER OF BILL: H. R. 8157 DATE INTRODUCED: AUGUST 2, 1919	THE LENROOT BILL *The National Railroad League Plan* NUMBER OF BILL: S. 2889 DATE INTRODUCED: AUGUST 27, 1919	THE CUMMINS BILL *Plan of Senate Committee Chairman* NUMBER OF BILL: S. 2906 DATE INTRODUCED: SEPTEMBER 2, 1919	THE FRELINGHUYSEN BILL *A Modification of the Cummins Bill* NUMBER OF BILL: S. 2998 DATE INTRODUCED: SEPTEMBER 15, 1919
OWNERSHIP AND OPERATION	Private, by existing organizations.	Government ownership. Operation by corporation controlled chiefly by employees and paying out of operating receipts a rental equal to the fixed charges on capital employed.	*One* privately owned corporation under supervision of the Interstate Commerce Commission, the directors of which are to be selected as shown below.	Private ownership under Federal incorporation and control.	Private ownership and operation by "National" companies under Federal charter.
MERGERS	Mergers permitted if in the public interest and if approved by the Interstate Commerce Commission.	All roads to be operated by one corporation for "public service and not for profit."	No provision.	Present railroad systems to be merged into not less than twenty nor more than thirty-five separate and distinct corporations.	Mergers and consolidations to be under supervision of Federal Transportation Board.
REGULATION OF SECURITIES	Federal regulation of the issuance of securities.	Government bonds to replace railroad securities now outstanding on the basis of an official appraisal.	To be controlled by Federal regulating body.	Control and regulation by Interstate Commerce Commission.	To be controlled by Federal Transportation Board.
CONTROL	Federal control to be broadened and intensified.	Continuation of powers of Interstate Commerce Commission. Directors of operating corporation to be selected, one-third from non-appointed (or "classified") employees; one-third by appointed officers and one-third by the President by and with the advice of the Senate.	Eleven directors appointed by the President of the United States from a limited number of candidates proposed by stockholders and various organizations (viz., agricultural organizations, Interstate Commerce Commission, National Association of Railway Commissioners, U. S. Chamber of Commerce and railroad employees).	Board of Directors of each corporation, in addition to private ownership representation, required to have at least two members representing the "classified" employees and two members representing the Government (the latter to be appointed by a newly created Transportation Board).	National railroad companies to have twelve directors, two of whom shall be employees representing brotherhoods, the remaining members to be elected by the stockholders, two of whom are to be nominated by the Transportation Board.
RATES AND RETURN ON CAPITAL	Interstate Commerce Commission to determine just and reasonable rates. Commission may establish minimum as well as maximum rates. No guarantee of or limitation on return on capital.	Under regulation of Interstate Commerce Commission. When the Government's share of the distribution of net earnings exceeds 5% of gross operating revenues, a reduction in rates is to be effected to absorb the excess.	Existing Federal control over rates. Dividends to be not lower than 3½% or higher than 6%. Government to guarantee not less than 3¼% and not more than 4% on capital stock of corporation.	The Interstate Commerce Commission to divide the country into rate districts, and, after hearings, to determine schedule of rates adequate to furnish a fair return on capital in each district. A Railway Transportation Board of five members to make continuous inquiry and report to Interstate Commerce Commission respecting adequacy of rates, transportation needs and facilities, state of railroad credit, etc.	*Traffic sections* created for determination of rates. One-half of net earnings in excess of 6% on fair value of property to be applied to a company contingent fund and the remainder to a general railroad contingent fund. When the company contingent fund amounts to more than 6% of the fair value of its property, it is to retain only one third of the excess above this 6%.
DISTRIBUTION OF PROFITS	No provision regarding distribution or apportionment of profits.	Net earnings after payment of rental are to be divided; and one-half distributed to the Government for use in extensions, amortization, etc., and one-half distributed as a dividend to officers and employees in proportion to their annual wages.	After deduction of all fixed charges earnings in excess of maximum dividend requirements to be shared as follows: labor, 40%; stockholders, 30%; Government, 30%, to be used for reimbursement for funds advanced to corporation, any portion not so utilized to be held in trust by corporation as an operating reserve fund or for dividend or interest requirements.	"Excess" earnings over a fair return to be paid to the Railway Transportation Board, one-half of which is to be used for the betterment of laboring conditions of railway employees, and the remainder to be used for purchase of equipment or for loans to other railroads.	Whenever a company fails to earn 6% on its fair value it may draw on its contingent fund for the purpose of paying interest and dividends. The general railroad contingent fund is to be used for the purpose of making good any deficiency in any year on the aggregate annual operating income of railroad companies in each traffic section below 6% per annum on fair value of property.
FINANCING	All financing (except issues of notes maturing in less than two years) to be approved by the Interstate Commerce Commission.	All financing is to be undertaken by the Government.	Existing bonds may be assumed by corporation. New stock with maximum annual dividends of 6% exchanged for existing stock as appraised by the Commission.	All financing to be authorized by the Interstate Commerce Commission with the recommendations of the Railway Transportation Board.	Funds in excess of $750,000,000 accumulated in general railroad contingent fund to be used in national railroad development. A reserve fund of $500,000,000 to be appropriated to finance railroads for ten years in case the contingent fund provided from earnings for this purpose is insufficient. Provision also to be made for advances by Federal Government to companies with weak credit from a fund of $300,000,000 appropriated.
JOINT USE OF TERMINALS, ETC.	To be under the direction and authority of the Interstate Commerce Commission.			To be under the direction and authority of the Transportation Board.	To be subject to the direction of the Transportation Board.
WAGES	No provision.	Wages to be adjusted by district boards composed equally of "classified" employees and appointed officials. A central wage board to be provided with final jurisdiction over the broad questions of wages and working conditions.	Creation of labor mediation boards with equal representation for labor. Labor guaranteed the right to organize and bargain collectively.	A committee on wages and working conditions, composed of an equal number of representatives of the wage-earners and of the companies to consider labor disputes. Its decisions to be certified to Transportation Board. Decision of Transportation Board to be final.	Wages to be adjusted by boards composed of an equal number of representatives of the railroad companies and the employees. Recommendations of such board to be binding, but in case of deadlock to be referred to Federal Transportation Board.

Continuing a series of interviews with contractors:

Construction Labor's Instability

An Analysis—

III—In which E. S. Skillin, vice-president of the Snare & Triest Company suggests increased production by greater use of labor-saving machinery as a palliative.

IF THERE were two men for every job instead of two jobs for every man, labor's restlessness would be materially quieted. The labor shortage is largely responsible for the difficulties in dealing with the various questions arising between employer and employees. E. S. Skillin, vice-president of the Snare & Triest Co., New York City, thoroughly believes that many questions concerning the present labor situation would clear should there suddenly become available more men than jobs to put them on.

"There has been little or no immigration into the United States during the past five years," says Mr. Skillin. "Before that time an annual influx of approximately 300,000 foreigners gave us plenty of common labor. At the outbreak of the war many of these men were called to serve in the armies in their respective countries. The ranks of labor began to be depleted at that time, and when the United States entered the war many of our own men were mobilized. The shortage of labor was felt considerably, even while the war was in progress, but it is now becoming daily more acute, due to the departure from this country of men of foreign birth who are returning to their European homes. Emigration from this country now amounts to approximately 10,000 per month, or a greater number than were counted as immigrants during the pre-war period."

With this decrease in the number of laborers and building-trades men available goes a marked fall in the efficiency of workmen in general.

Another reason why there is such a labor shortage, particularly among building tradesmen, is due to the fact, says Mr. Skillin, that comparatively few young men, either of American or foreign parentage, are entering the building trades.

Contributing to the instability of labor is the uncertainty as to what living costs will be from month to month. Superintendents of the Snare and Triest Co., in talking with their men, have tried to impress upon them the dignity of the contracts with their employers. The contractor has indicated to the labor leader that when he cannot rely upon his contracts for labor the resulting conditions militate considerably against bidding for contract work. The reply to the contractor has always been the same, "If you will guarantee us that the cost of living will not increase during the life of the contract we will guarantee that no wage increase will be demanded." The guarantee naturally cannot be given, and the prices of labor and of materials produced by labor remain indeterminate.

Mr. Skillin does not believe in the efficacy of any scheme admitting the laborer to constant share in the profits that he may aid his employer in securing. "Such a scheme may be applicable to organized industry, where personnel is a constant factor," states Mr. Skillin. "In contract work but a small percentage of your working forces ever approach a constant figure. With the labor turnover so great and with the adjustment of your working forces to each individual job, it is obvious that a system whereby the laborer shares in the profit or loss of a contract job is not feasible." Mr. Skillin did agree, however, that on wartime construction bonuses had secured beneficial results. The extension of the system on certain classes of work would, in his judgment, be of advantage to both labor and contractor, but it is not applicable to many classes of work, and in any event, where prize giving or bonus giving are frequently indulged in, it resolves itself merely into an increase in wages. Piecework as well has been tried. On urban construction, where unions exercise vigilant control, both these systems are practically impossible, being in opposition to the fundamental of unionism that each man is supposed to do the same amount of work for the same compensation when employed in the same line of work.

Several possibilities present themselves to Mr. Skillin as solutions of the shortage of labor which, if corrected, would, in his judgment, solve many incidental difficulties. In order to reverse the present condition, so that, instead of there being two jobs for each man, there will be two men for every job, there is but one alternative if the Federal restriction upon the importation of foreign labor continues—increased production.

Evidently, then, the shortage of labor demands extensive use of labor-saving machinery on construction work, in order to secure that increased production. The accomplishment of such a task is further hampered by labor's almost universal demand for shorter hours of employment.

Mr. Skillin's answer to the question, "What is the matter with labor?" is, therefore, "Decrease the necessity for it."

"Engineering News-Record" has undertaken this series of interviews with a single aim—to aid the contractor. Contractors' difficulties with construction labor, and their suggestions as to corrective measures are presented with the idea of evoking a general discussion from which may crystallize some concrete plan for the settlement of this absorbing question. We invite discussion of these articles and additional comment or suggestions on the labor problems by those contractors with whom we are unable to communicate personally through our editorial representatives.—EDITOR.

Cincinnati Completing Its Meter Program

About 98% of the water consumers of Cincinnati were metered Dec. 1. Two years ago orders were given that meters must be installed on all unmetered taps by the close of 1919. Since then about 16,000 meters have been set, leaving about 1000 more to be placed. Consumers pay the first and maintenance costs of meters. The meter rate is now 12c. per 100 cu.ft., regardless of the quantity used. There has been a 50% advance in the meter rate within a year or two. J. A. Hiller is engineer and superintendent of water-works.

Niagara Railway Arch Reinforced for Heaviest Traffic

Capacity Increased To Meet Increasing Traffic Demands—Stresses in 550-Foot Arch Span Redistributed by Changing Crown Shims—Floor Reconstructed for E70 Loading—Bracing and Reinforcement

STRESS readjustment in the 550-ft. steel arch of the double-track railway bridge crossing the Niagara Gorge at Niagara Falls, N. Y., was carried out successfully Oct. 1, 1919. This operation was virtually the last step in an extensive repair enterprise which in its entirety was based on strain-gage measurements of primary stresses, secondaries and impact. Various important studies of fundamental questions in bridge design were necessary accompaniments of the investigations.

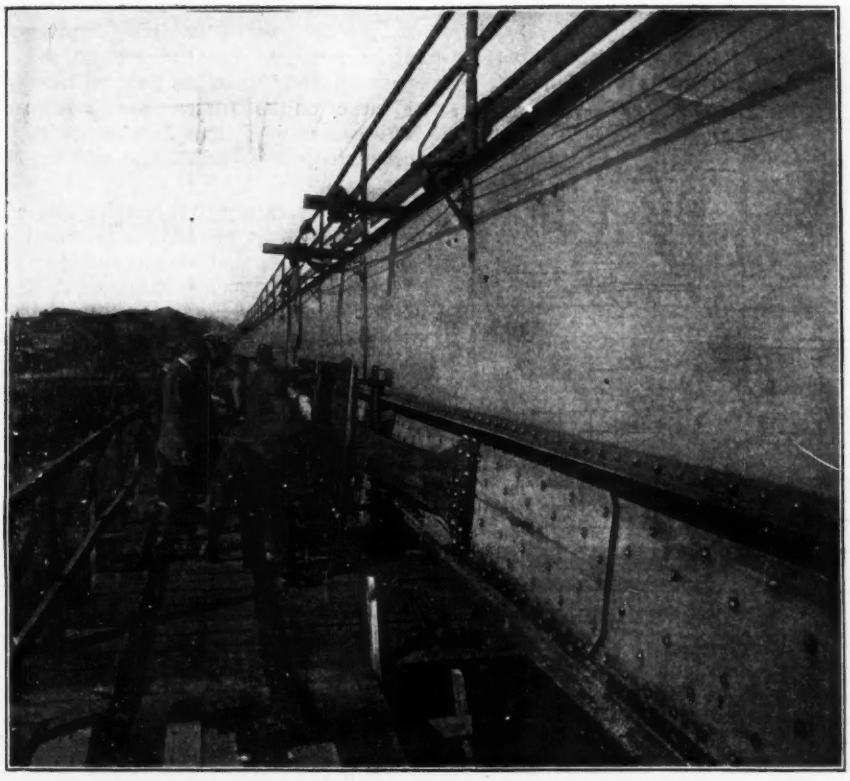


FIG. 1. NIAGARA RAILWAY ARCH: FORCING APART THE CROWN JOINT OF THE TOP CHORD BY TOGGLE

Broadly speaking, the result of the reinforcement has been to convert a bridge built 22 years ago, and then intended to be capable of carrying a traffic equivalent to about Cooper's E37 loading, into a structure equal to one designed and built today. The floor has been rebuilt with strength sufficient to carry E70 loading on both tracks. The main members of arch and approach spans are adequate for E60 loading on both tracks, or singleheaded E70 loading on both tracks, or doubleheaded E70 loading on a single track; and with speed restrictions even heavier trains may be moved over the bridge.

Reference to drawings of the bridge (See *Transactions*, Am. Soc. C. E., 1898, Vol. XL., p. 125) will show that the bridge was originally designed with low unit stresses and an excellent, robust makeup of members and details; these were the main factors that made it possible to increase the capacity of the bridge so greatly in the present work. No deterioration whatever had taken place in any part of the arch, except for heavy corrosion of the railway floor members through salt-water drip from trains. A large number of bad and loose rivets was found, but it is uncertain whether these became loose during the service of the bridge or were bad and did not fill their holes from the beginning. After taking care of these two matters, the remaining reinforcement was based on a careful survey of the structure with regard to the metal cross-sections available and the distribution of stresses. One outstanding result was that the main arch proved to be amply strong (when properly adjusted) for the much higher loading of modern design, though its crown closure, the arch being statistically indeterminate, was of such nature that the stresses in some members were excessive and a readjustment had to be undertaken to distribute the stresses more equally to the various members.

In the original design of the bridge a moving load of 10,000 lb. per lineal foot was provided for. This includes the loading on both decks (the lower carrying a highway, the upper deck two railway tracks). At the beginning of the investigation of strength, made last year, the conclusion was reached that this loading allowance corresponded to approximately E37 on the railway tracks. For a year past train speeds have been limited on the bridge, in view of the known increase of locomotive and car weights since the construction of the bridge. Charles E. Fowler, called in to investigate the condition of the bridge, concluded at the outset that because of the probable overloading of the structure, as well as because of its statically indeterminate nature, a reliable determination of the capacity of the bridge would have to be based on measurements of actual stresses existing in the members under known loading. It was found in the course of speed tests that the bridge had a rather excessive amount of side sway, but the importance of impact effects could not be known without stress meas-

urements. Because all connections of the main members of the bridge are riveted, it was thought that secondary stresses might be high, and the conclusion was was reached that their amount should be measured before attempting to fix upon the maximum safe stresses which the various members would bear.

A campaign of strain-gage measurements for this purpose was authorized by the directors of the company owning the bridge, more than a year ago. The measurements were made by Mr. Fowler, assisted by Prof. C. T. Morris and Prof. A. H. Fuller. (See a summarized statement of the work in *Engineering News-Record* of Dec. 26, 1918, p. 1172.) Impacts up to 50% were observed in the arch members, though the values as a rule were far below this amount. From the observations, curves for the variation of both impact and

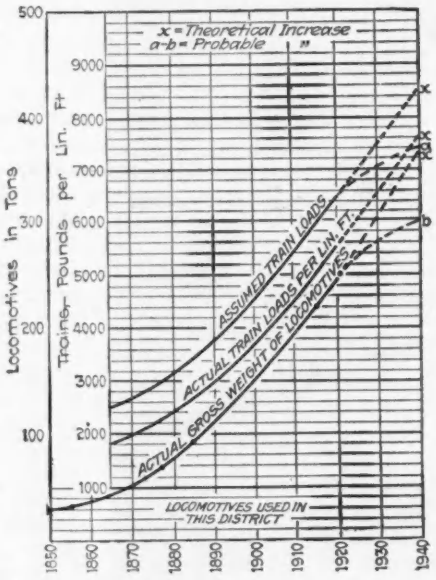


FIG. 2. RAILWAY LOAD INCREASE AT NIAGARA CROSSING DURING SEVENTY YEARS

secondary percentage with loaded length were plotted, and these after fairing were averaged for a given class of member to give a mean curve for the final calculations.

One of the byproduct results of the strain-gage work was the discovery that the wrought-iron sway rods between the long posts of the arch web-system were quite unevenly stressed; immediately on the completion of the measurements, therefore, these rods were readjusted to strain-gage readings. Auxiliary transverse struts were also riveted between four sets of posts to reduce the free length of compression member in cases that appeared critical. Furthermore, about 11,000 rivets in main truss connections that were found to be bad or loose were cut out and redriven. General reinforcement, however, was only planned at that time, and it was not undertaken until the current year.

Loads and Stresses

One of the first and most gratifying conclusions of the strain-gage work and the coördinated study of the bridge stress sheets was the discovery that the main arch had been built originally with such ample section of members as to be capable upon readjustment of carrying far more than the designed live load. In fact, it seemed possible to adapt the arch to live loads heavy enough for a considerable period of future service, and on this account a study of railway live loads was made to determine what might be looked for as the future maximum. Mr. Fowler's conclusion was that a locomotive weighing about 300 tons and trains weighing about 7500 lb. per linear foot of track might be looked for at the end of a period of about 20 years, as maximum railway rolling loads of that time; and that for the terminal traffic on this bridge (which is located within the switching limits of large terminal yards on both American and Canadian banks) an E60 locomotive loading with somewhat lighter train loading than 6000 lb. per foot would be fairly representative for many years to come. Local concentrations, of course, would have an effect upon the floor without being of material influence on the trusses. For these reasons a loading of E70 was decided upon for the entire floor and for the plate-girder approaches, and E60 for the main parts of the structure.

It was necessary to determine also what unit stresses might safely be allowed in the main members of the bridge. Stress analyses showed that with unit stresses —impact and secondary stress being allowed for as noted below—of 20,000 lb. in tension on built members and approximately 19,000 lb. in compression (reduced for length of member), the full desired loading could be accommodated both on the arch and on the approach spans, provided a few weak spots of the approach spans were reinforced. In the case of the floor of the main arch span, the floor of the 115-ft. spans, and the whole of the plate-girder approaches, lower unit stresses were applied, as the extensive renewal and repair of parts here, made necessary by corrosion, allowed the stringers to be given ample section. With respect to the floor-beams, other means of reinforcing were devised, as will be related.

From the strain-gage measurements it was determined that, while impact effects seemed to vary somewhat erratically, they were in general well taken care of by allowances based on the Pencoyd or Schneider formula. The amounts actually used in the final calculations were for most load lengths considerably less than given by this formula, however, because a low maximum speed, 17 miles per hour, was decided upon, the stress measurements having shown that at speeds much beyond this the impact effects increased.

Secondary stresses were determined by the measurements to range from about 10% to 200%. The amounts adopted for the final calculation of the top chord varied from 20% to 200%; those for the web members of the main arch from 15% to 60%; for the bottom chord 10% was used and for the main members of the approach spans 23%. These percentages were applied to the live-load stresses alone, on the assumption that dead-load secondaries were neutralized by adjustments before erection was completed.

Reconstruction and Reinforcement

First and in some respects largest of the reconstruction items to be undertaken was the rebuilding of the floor. This consisted of renewal of flange plates and to some extent flange angles of the stringers, an operation that was carried on for one track at a time. In connection therewith a shelter or drip plate was built in under the ties, an ingenious new design that was described in *Engineering News-Record* of Sept. 25, 1919, p. 620. No

additional flange metal was found necessary in the floor-beams, in spite of the very greatly increased train loading, because it was possible to give these added support from below by strengthening the large curved knee-brackets between posts and floor-beams. In the cross-section in Fig. 3, taken from the 1898 description of the original bridge, the form of these brackets as originally applied is clearly shown. They were extended about 18 in. toward the middle of the floor-beams, by riveting extension clips to the floor-beam flanges, and a full-length additional cover plate was riveted over these clips and the original knee-brackets. An analysis of the stresses in the square frame formed of upper-deck and lower-deck floor-beams, arch posts and brackets showed the function of the brackets to be so important as to make the upper floor-beams nearly adequate, and wholly so if the brackets were extended.

In spite of full upper and lower lateral systems (the lower laterals consisting of rigid members and the upper laterals of crossed diagonals of angles in the plane of the railway floor), the bridge had more side sway than was considered safe for modern loads. This was traced to the use of very light rod bracing between the high arch posts; it was therefore decided to remove the rods and put in rigid bracing. The substitution actually brought about a marked reduction in the vibration of the bridge under railway traffic.

A minor item of the floor work was the replacement of the wood joists of the highway floor by steel joists having a capacity for 15-ton trucks. These joists are 9-in. I-beams, placed transverse to the axis of the bridge, 2 ft. 4 in. apart. The new planking of 3½ in. oak was laid longitudinal, as in the original floor.

While no reinforcement of individual members was

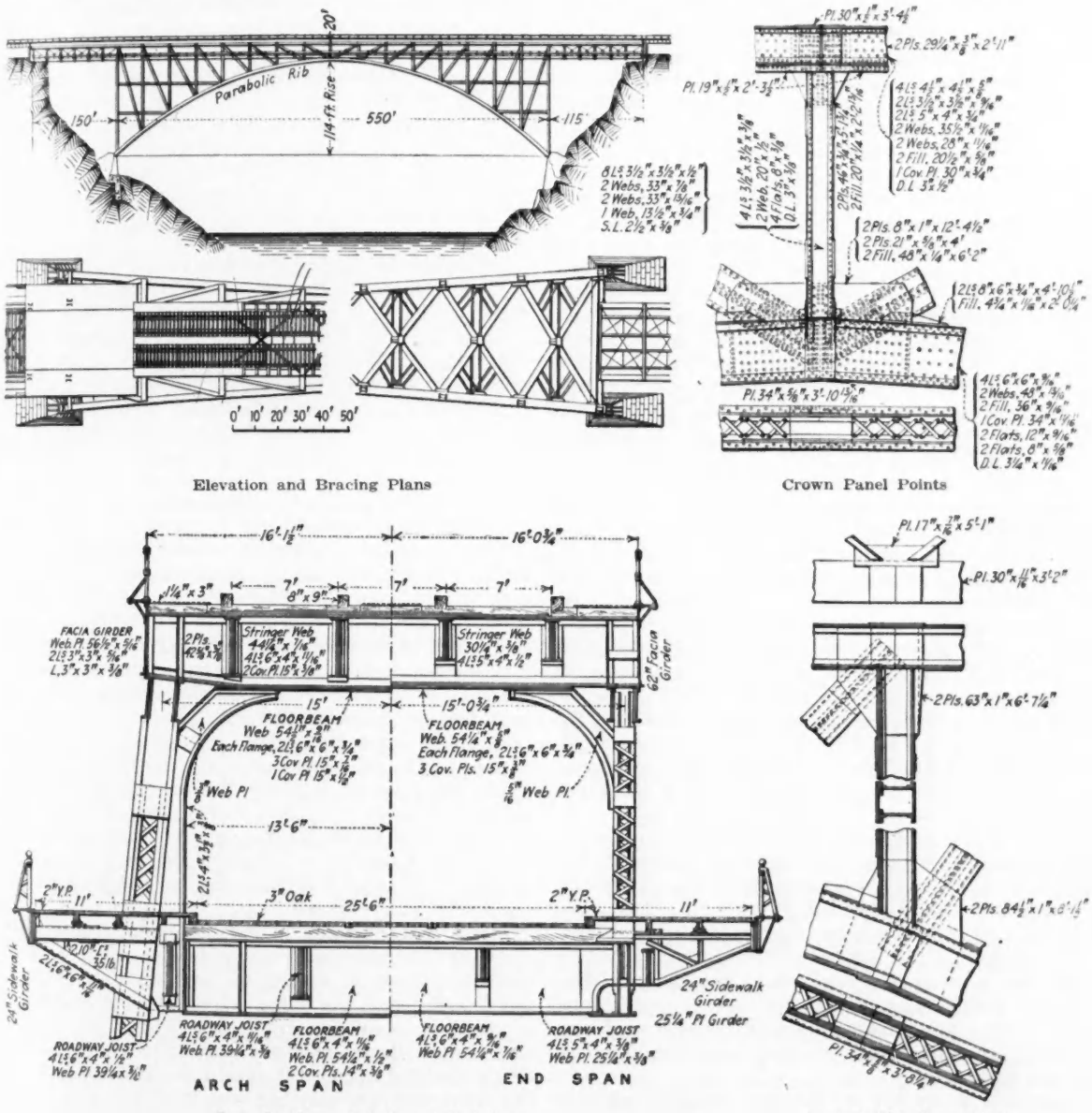


FIG. 3. TYPICAL SKETCHES OF NIAGARA RAILWAY ARCH AS ORIGINALLY BUILT

necessary in the arch, the approach span presented an interesting problem in this regard. The chords of these spans were originally built with a large excess of section, the top chords having been used as parts of the anchor chain in cantilever erection of the main arch, and the bottom chord eyebars (these spans are pin-connected) having been proportioned for very low unit stresses. The diagonals also were ample, except the counters. The posts, on the other hand, called for some addition of section and for stiffening laterally, to resist the transverse bending imposed by the knee-brackets of the railway floor. For this purpose two vertical angles were riveted along the face of the posts, on the side facing the center line of the roadway. To apply these angles in such a way that they would share the total stress with the original metal of the posts, the posts were relieved of their load by placing a powerful toggle between upper and lower chord, and by this means spreading the chords apart just sufficiently to slack off the pressure on the post pins, as described in *Engineering News-Record* of Oct. 16, 1919, p. 743.

A number of other items of reconstruction and repair were carried out in connection with the work described, but of wholly auxiliary character. One of these was raising the level of the railway tracks near the American end of the bridge by 18 in., to eliminate a sag in the profile originally built in. This required raising of the American plate-girder viaduct approach to the bridge and other rearrangement.

Stress Readjustment in the Arch

In the original investigation of the bridge by strain-gage, last year, it was necessary to determine the dead-load stresses by measuring the stress in one member. Without such a datum-point the amount of constraint existing in the statically indeterminate structure would have remained unknown. A toggle was therefore built, by means of which the top chord of one arch truss was spread apart at its crown joint after removing the splice plate; the increase of length of a measured gage length of top chord inside the reach of the toggle, while the original dead-load stress in it was being reduced to zero through the operation of the toggle, was a measure of the dead-load stress. The amount of stress so found was 689,000 lb. in the middle section of the top chord (of one arch truss).

Stress calculations based on this figure led to the conclusion that the top chord and the web members of the arches were relatively overstressed, while the bottom chord or rib could carry more stress with safety. Undoubtedly one of the reasons for this condition is that, in the original design of the structure, the rib section was increased over that required by the stress calculations for the two-hinged arch, to areas representing the mean between the two-hinged and the three-hinged conditions. This was done "to meet any inaccuracy of adjustment."

The original stresses in the arch corresponded to a dead-load stress in this member of 572,000 lb.; the fact that a larger amount was found was undoubtedly due, says Mr. Fowler, to the fact that in the closure of the arch, when the top chord was forced apart at the crown by the anchorage toggles and adjusted with a small crown toggle, and shims of the thickness calculated as desired were inserted, the amount of stress introduced into the chord by the toggle was more than the required amount.

Without regard to the original stress-sheet, however, recalculation of the arch was carried through on the basis of the new live load and the new unit stresses considered allowable; and several degrees of constraint in the arch were assumed for this purpose, in order to determine whether any gain could be made by different degrees of redistributing the stresses. It was found that if the constraint introduced by the shim at the top-chord crown joint could be reduced to less than half its existing amount, the top chord and the web members would be favored by relief of their excessive stress, while the bottom chord would be subjected to an increase of stress, which, however, it could take care of. It was therefore concluded to readjust the top chord closure in such a way as to put a dead-load stress of 300,000 lb. into this member, in place of the actual 689,000 lb. or the 572,000 lb. contemplated by the original stress sheet. Elastic calculations showed that this reduction of top-chord stress would be brought about by removing the 1-in. shims in the top-chord crown joint and replacing them by shims about ⅝ in. thick (varying from 37/64 to 43/64).

To force the top chord apart for the readjustment indicated, two sets of powerful toggles were constructed, each consisting of two sets of three bars engaged at their hip points by vertical toggle-beams serving as pulling heads for four screws, one above and one below the toggle bars at each hip point. These parts may be seen in the view Fig. 1, showing the toggle in place and under operation for readjustment. The ends of the toggle were butted against abutment plates originally riveted to the chord at the time the arch was closed, and strengthened by extra plates at the abutment edge to protect it against curling up under the pressure.

The toggles were operated simultaneously on both trusses. Traffic over the bridge was stopped at 8 a. m., Oct. 1, 1919, and the work on the screws began at 10 a. m. On a whistle signal, a pair of workmen at each end of the screws proceeded as rapidly as possible to give the nut at that end four turns. By thus carrying the work on according to signal, all working points were kept abreast of one another. By noon, the stress had been fully transferred from the chord joints to the toggle and the shim was loose. After noon the old shim pieces were taken out, and the toggles then slowly slacked off until the new shims were in and were gripped, after which the toggle nuts were slacked off as rapidly as possible to bring the joint to full bearing. At 4 p. m. the joints had been bolted up and traffic across the bridge was resumed.

Stress measurements in the top chord immediately afterward showed a large stress deficiency as compared with that aimed at. One of the top chords showed only 100,000 lb., and the other about 200,000 lb. stress (instead of 300,000), the total deficiency thus being about 50%. By the next morning, after a heavy traffic of accumulated trains had gone over the bridge during the night, this deficiency had been largely corrected, and it decreased still further during the following two days, so that the stress varies less than 6% from that required. It was evident that the larger part of the stress which should have appeared in the top chord remained as compression in the railway stringers and the track rails and guard rails of the upper deck (100-lb. rails laid with joints tightly butted), and that the rolling action of the trains gradually worked the stress out of the stringers and rails.

In view of the deep chord and gusset-plate connection at the crown of the bottom chord (see Fig. 2) it was feared that the ⅜-in. shortening in the top chord by the change of shims would introduce very heavy secondary stresses in the members surrounding this joint.

To forestall this, the lower half of the splice and gusset connection was disconnected by cutting out the rivets, and the upper edges of the gussets were cut back in a sweeping curve by flame burning. The final closure of the splice by re-riveting was not made until some

FIG. 4. ROD BRACING BETWEEN POSTS, NOW REPLACED BY STIFF MEMBERS

weeks after the shim adjustment, in order to give full opportunity for the parts to adapt themselves to the new conditions without elastic distortion.

The entire operation was carried out by the Terry Tench Co., contractors, in coöperation with H. G. Dickinson, superintendent of the Niagara Railway arch bridge, under the direct superintendence of the consulting engineer.

Masonry and General

The masonry of the skewbacks, pedestals and abutments was generally in good condition, but there was a rather alarming eccentricity of stress at the base of the arch skewback piers. Incidentally, the masonry of the abutment of the Canadian approach (four 52-ft. plate-girder spans) was badly shattered under the bearings. This was the original abutment and anchorage of the Roebling suspension bridge built 64 years ago, remodeled into an ordinary abutment when the arch bridge was built in 1897. The shattered masonry was removed and a new concrete facing constructed by erecting forms in front of the old masonry and pouring the concrete against the old stone wall. Two of the approach viaduct pedestal caps also were found to be cracked, and they were removed and built steel shoes were substituted. The old capstones were found to be badly shattered upon removal.

The skewbacks of the 550-ft. arch span were built of limestone masonry, with granite coping or capstones. This masonry was just beginning to show weathering, and it was found to be necessary to protect it in an efficient manner. Triangular mesh reinforcement was placed over all the surface, and an armored coating formed over the mesh by cement gun. The coating was made about 4 to 6 in. thick at the top and from 6 to 12 in. thick at the bottom. The eccentricity of the pressure lines within the skewback masonry and the heavier loads to be carried by the structure made it necessary to connect the separate skewbacks by a 4-ft. reinforced concrete thrust and tie wall, reinforced diagonally with sixteen 1-in. rods hooped as a column, to carry the thrust from the top to the rock at the base.

Land Values Raised by Drainage

Engineer Cites Cases Where Drained Lands Sell at $200 to $300, While Former Value Was $10 to $20 per Acre

THE important commercial results of engineering work for land drainage are illustrated by examples of the great increase of land prices in drainage districts, as mentioned in a paper read at the recent meeting of the National Drainage Congress by Isham Randolph, consulting engineer, Chicago. In the Little River District of about 800 square miles, in Missouri, the best lands were sold at an average price of $16 per acre before the drainage was begun, although the district had been organized.

During 1918 and 1919 the average price was $55 per acre, and some of the drained land has sold as high as $75 per acre.

Concerning smaller districts in Missouri, the following figures may be cited: District No. 1 in New Madrid County, was organized in 1898, and during 1899 several thousand acres of the best lands on the higher ridges were sold at an average of $6.30 per acre. Drainage work was completed about 1902, and during 1902 and 1903 land was sold at an average of $9.70 per acre, while a fair average at the present time would be $125 per acre, and some sales have been made at close to $200 per acre.

In the Spring Lake District, in Illinois, before reclamation, the fair market value was about $3 per acre, but now the price is firm at $300. In the Banner Special Drainage and Levee District, in Illinois, with 46,000 acres, the price before reclamation was about $3.60 per acre, while now it is $275 to $300, and in a partition suit the commissioners have appraised uncleared property on the basis of $300 per acre. One year after drainage a tract formerly valued at $25 per acre produced onions which sold for more than $800 per acre. As the cost of raising the crop was something over $200, the net return on the land was $600 per acre for that year.

Concerning Arkansas, Mr. Randolph quoted from a letter by Willis Ayres, consulting engineer, Memphis, Tenn. In Mississippi County, Arkansas, approximately $5,000,000 has been expended for drainage in the past 10 years. Cut-over land, where all merchantable timber has been removed, was unsalable at $10 an acre 10 years ago. Today that same land is selling at $150 to $200 per acre.

In Crittenden County, Arkansas, next year practically the entire county will have been drained at a total expenditure of approximately $3,000,000. Undrained, cut-over land was selling at $5 to $10 per acre in 1912-1913 and developed property at $30 to $50. Now land of the same type, properly drained, is bringing $50 to $75 per acre if undeveloped and $150 to $250 per acre if developed.

Various Current Phases of Sanitary Engineering

Brief Abstracts of Papers, Reports and Resulting Discussions at the New Orleans Meeting of the American Public Health Association

ENGINEERING and allied technical subjects received much attention at the 47th annual meeting of the American Public Health Association, held at New Orleans, Oct. 27–30, 1919. The news features of the convention were reported in the issue of Oct. 9, p. 714. Below are brought together brief abstracts of some of the papers and reports on drainage and mosquito control, engineers as health officers, water-supply, sewage treatment, refuse disposal, milk pasteurization, and the sanitary control of swimming pools. More extended abstracts of a few papers may be published in later issues.

The importance of drainage as an antimalarial measure, and the need of having health officers supervise drainage for land reclamation in order that conditions favorable to mosquito breeding might not be created, were urged by J. A. LePrince, senior sanitary engineer, United States Public Health Service, Memphis, Tenn. Some figures of cost of malaria control, based on experience in the United States, were given by H. R. Carter, assistant surgeon general, United States Public Health Service, who said the best method of control is the one that costs the least. In some sparsely settled localities control by drainage might be prohibitive in cost, so that screening and quinine would be the only available means of combating malaria.

W. G. Stromquist, assistant sanitary engineer, United States Public Health Service, Memphis, Tenn., spoke of the need for ditching machines that will cut small trenches with V-shaped bottoms. To prevent aquatic growths in ditches, the slopes may sometimes be lined with cement shot onto wire. Mosquito control is vital to agriculture, lumber, steel, railway and other industries in the South. Both the Tennessee Coal, Iron and Railway Co. and the Cotton Belt Railroad have done effective work against mosquitos. Continuing this line of discussion, Mr. Le Prince said that malaria control in the South is a vital question to the North as well, since malaria hampers Southern industry and swells the cost of Southern products.

Engineers for Health Officers

Renewing a topic presented before the association seven years ago by Morris Knowles, a paper entitled "New Specifications for Health Officers," by Mr. Knowles and Morris R. Scharf, was presented by the latter. The paper had much to say of the work of the sanitary engineer in protecting public health. It urged that local, state and Federal health officers be trained and experienced in "sanitation, public health and public health administration"; advocated a permanent sanitary corps and sanitary reserve corps in the United States Army and that sanitarians should be commissioned in the United States Public Health Service. Dr. A. W. Freeman said the paper was timely, since in Ohio 102 full-time health officers must start work Jan. 1. For the larger cities, these administrative positions may be filled with doctors or with sanitary engineers trained in public-health work; in the smaller places, doctors will probably be needed, since the health officers there will have medical functions. C. A. Emerson, Jr., engineer, Pennsylvania State Department of Health, thought that to fight disease a medical officer is needed, but one with special training. M. N. Baker, New York City, expressed particular interest in the paper, because he had taken a part in securing a succession of engineers and men with allied training for health officers at Montclair, N. J., including Theodore Horton, M. O. Leighton, H. N. Parker and C. H. Wells. When the last-named left Montclair to become health commissioner of Delaware he was succeeded by John Gaub, at that time chemist of the Washington water-filtration plant. Ultimately, Mr. Baker thought, neither a full medical nor a full sanitary engineering course will be considered essential for a health officer, but a course made up from both. Eventually, sanitary engineering work may be taken from boards of health, state and local, and placed in well planned engineering departments. In that event it will matter less if the main training of the health officer be medical, provided it be grounded in public health instead of private medicine.

Water-Supply and Purification

In his report as chairman of the committee on water-supply, George G. Earl, general superintendent, Sewerage and Water Board, New Orleans, first urged that neither privately nor publicly owned water-works can be properly operated unless every one benefited pays his fair share of the cost of the service. After mentioning the dangers of permitting the use of impure secondary water-supplies, Mr. Earl reviewed the beneficial effects of improved water-supply, sewerage and drainage on the health of New Orleans. From 1899 to 1918 (eliminating the influenza toll from the latter year) the general death rate of New Orleans fell from 27 to 19. In the same period, malaria dropped from 104 to 4 per 100,000 and typhoid fever from 39 to 18 (the latter the average for the past seven years). There is no reason to think, Mr. Earl stated, that the water-supply has or ever did have any relation to typhoid in New Orleans, typhoid reduction being due to the elimination of privies and cesspools and also to the activities of the health department.

In a paper on "Water Purification in Ohio," W. H. Dittoe, chief engineer, Ohio State Department of Health, stated that of 81 surface water-supplies 51 are filtered and 9 rely on chlorination. The population dependent on the 21 untreated supplies totals 100,000, compared with 3,000,000, or 56% of the population of the entire state, dependent on treated supplies. When the department began the supervision of water treatment in 1916 only 8 of 38 filtration plants were in charge of trained operators and only 1 of 8 chlorination plants. Each of the 15 new plants built in the last 3½ years is in charge of a competent operator. Today 21 water-treatment plants in Ohio are under the supervision of technically trained men; 22 plants have the part-time supervision of such men, and only 8 are operated without proper supervision—but the largest of these furnishes no more than 800,000 gal. a day. Of 9 chlorination plants, 8 are under trained men. In many cases the saving in operation effected by having competent men in charge exceeds the salaries paid.

A typhoid outbreak due to the negligent operation

of the water purification plant at Charleston, W. Va., in 1917, was described by Mayo Tolman, lately engineer of the West Virginia State Department of Health. The plant lacked accessories and was out of order. No coagulant was used when the water was clear. On various dates the filter was bypassed and only a slight dose of chlorine was used. In discussing the paper, Dr. A. W. Freeman, who was detailed to Charleston by the United States Public Health Service, said that the negro in charge of the filter plant determined the amount of coagulant to use by looking out the window at the river water. The plant had no intelligent supervision. Bacterial counts were made by a local druggist. At intervals, samples for bacterial examination were sent to the state laboratory, but they were 24 to 72 hours en route.

In the course of a paper on "Causes of Typhoid Fever in Massachusetts," by George T. O'Donnell, it was stated that since 1896 public water-supplies had not caused any considerable number of cases of typhoid fever in Massachusetts. In one instance, a frozen water-filter bed gave rise to some typhoid. The typhoid mortality for the state has fallen from 12.2 per 100,000 in 1910 to 4 per 100,000 in 1918. Over 90% of the population has a public water-supply. The author thought the time will come when no typhoid case will be released until two negative cultures from both the feces and the urine have been obtained.

The pollution of deep wells from a sewage pump well at Lansing, Mich., was described by E. D. Rich, state sanitary engineer of Michigan. The pollution caused an outbreak of diarrhœa which affected thousands and crippled industrial plants for a few days.

Edward E. Wall, water commissioner of St. Louis, outlined the history, methods and results of treatment of water at St. Louis. Figures showing large sums of money saved by typhoid reduction, and by a lessening of soap consumption due to purer and softer water, were presented. The muddy character of the untreated water was illustrated by Mark Twain's statement that a tumblerful of Mississippi River water contains an acre of land in solution.

Sewerage and Sewage Disposal

For the committee on sanitary control of waterways, Harrison P. Eddy, consulting engineer, Boston, said that a study of the disposal of industrial wastes is proposed. As a preliminary, the committee submitted a bibliography on the treatment of industrial wastes.

The committee on sewerage and sewage disposal, Kenneth Allen, New York City, chairman, submitted a detailed report on the disposal of human excreta, garbage and manure in rural districts. Several members of the sanitary engineering section dissented from the committee's approval of earth-pit closets, and some thought the report contained proposals too elaborate and too technical for rural sanitation. A resolution was passed expressing appreciation of the work done on the report, but requesting the committee to postpone its final report until the United States Public Health Service completes its investigations of privies.

The report of the committee on sewage-works operation, submitted by C. B. Hoover, Columbus, Ohio, discussed methods and standards of sewage treatment to produce effluents which will not require dilution and also effluents subject to dilution. An abstract of this report will be printed later. W. H. Dittoe, engineer, Ohio State Department of Health, said he would like to see the expectations of various processes of sewage treatment tested in comparison with actual results. C. A. Emerson, Jr., engineer, Pennsylvania State Department of Health, said that during the war his staff was reduced and the inspection of sewage-works cut by half. On resuming full work it was found that only 20% of the works were being properly maintained. This was brought up to 60% after a force of 15 to 20 inspectors had been in the field.

A paper on the "Treatment of Wastes from Sugar Refineries," by S. A. Greeley, Chicago, described at length a beet sugar plant at Coro, Mich., and some experiments on sugar-waste treatment elsewhere. The conclusion drawn from the tests was that fine screens and settling tanks are likely to be needed at any plant and that the effluent could be treated on sprinkling filters or on sand filters.

Refuse Disposal

Through E. D. Rich, engineer, Michigan State Board of Health, the committee on refuse collection and disposal submitted a report which was designedly a compilation of material made public during the year. Included in the report were some useful data on feeding garbage to hogs, in the form of a tabular summary of the Baltimore, Buffalo and Newark contracts. The report stated that at some feeding plants much garbage is wasted because of failure to collect it until it is so stale the hogs will not eat it or because an insufficient number of hogs is kept. In the discussion of the paper, M. N. Baker, New York City, said that with present high costs for constructing reduction works and uncertainties as to the prices of grease and tankage there was much to be said for disposal by feeding to hogs, even if regarded as a temporary method. H. A. Whittaker, director division of sanitation, Minnesota Health Department, stated that there had been suits for nuisances on account of hog ranches at Minneapolis and other Minnesota cities. Mr. Baker replied that it required no more skill so to design and operate feeding plants as to avoid a nuisance than to design and operate reduction works.

Valuable contributions to public-health literature in a field but little surveyed heretofore were an extensive and detailed report by the committee on milk pasteurization, presented by H. A. Whittaker, director of sanitation, Minnesota State Department of Health, and a paper on control of pasteurization, by F. O. Tonney, director of laboratories, Chicago Health Department. Mr. Whittaker's report summarized reports received from various states on rules for control of pasteurization, and described at length the apparatus and methods employed. He estimated that there are now 4000 milk-pasteurization plants in the United States and Canada which are operating on domestic milk. The committee believes that pasteurization plants should be under the control of state boards of health except where there is competent local control.

The committee on swimming pools, through G. W. Simons, chief engineer, Florida State Board of Health, submitted a progress report. California and Florida are the only states that have placed swimming pools under the control of their state boards of health, and but few cities attempt control, only six having covered the matter by ordinance. The latter point is significant because nearly all the swimming pools are in cities.

Impressions Here and There

IN THE PACIFIC NORTHWEST

RECENTLY quite a stir developed among the engineers of Portland, Ore., when it became known that an outside firm had made an offer to the city to undertake its bridge-inspection work. "Shall the city contract for semi-annual inspections of all the city's bridges at the absurdly low figure of $500 per annum and agree to turn over to the same firm all the engineering work on new bridges at the usual percentage rate?" "No," said two groups of engineers after they were called together by their respective societies. And then they told the city fathers in a very emphatic way just how they felt about it.

They pointed out that "local engineers are best qualified to analyze local traffic growth and needs, and talent from other states should not be called in until problems justifying that course arise." After all, engineers *can* pull together effectively. The way they got together in this instance, and the publicity they secured for their views showed that very clearly.

Following the "paving boom," when Portland paved far beyond its rate of growth, the city became the unwilling owner of many lots on which assessments could not be paid—vacant, grass-grown lots bordered by unused but paved streets. For awhile no more paving was done, but of late the tide has changed again, this time to the sound policy of paving first on the more heavily traveled thoroughfares. This year the city has put in operation its own paving plant and has "declared independence."

Seattle—In Seattle, municipal ownership looms big. In addition to the city's hydro-electric project on the Skagit River, for which $5,500,000 has been voted, the street-railway system was recently purchased by the city for $15,000,000. Many ideas about up-to-date electric-railway operation new to Seattle are being tried, such as the pay-as-you-leave plan, a power-saving campaign among motormen, a merit and demerit system for platform men, etc. No municipal venture is without its opposition, and plenty of this is current in Seattle. "Why trust an entire hydro-electric development like the Skagit to a city where Cedar Falls dam stands as a monumental blunder?" "The sealing of Cedar Falls reseroir could be done better by contract than by the city." These are two of the comments. However, the way in which Skagit plans are being laid out indicates a determination to make no fundamental mistakes there. Dam borings are being made extensively at the three proposed sites, and comparative studies are under way to show the relative merits of steam railway vs. truck or tractor haul for the 26 miles between the nearest railroad and the dam site.

It is notable that the three largest cities on the Pacific Coast are now committed to municipal hydro-electric projects. San Francisco is developing power on the Hetch Hetchy and Los Angeles has in the aqueduct great water-power potentialities. In both these cases, however, water was the primary consideration. Seattle, on the other hand, has undertaken the Skagit project solely for the power involved—and counts on getting a good, big supply that can be sold at a rate attractive to manufacturers.

Pioneering is one of the things for which Washington is noted. It is not surprising to hear that the office of state hydraulic engineer has been created. (It is being ably filled by Marvin Chase.) Or that the new Pier B which the Port of Seattle is building will use timbers as large as 18 x 30 in. in section and 40 ft. long. But I must not bring forward only the favorable comment. A subject for the contrast comes to mind at once in one of the recently constructed bascule bridges over Lake Washington Canal. Picture the shapely steel truss, the carefully designed, massive masonry towers at each end, and then an unsightly high-level approach *supported on long wood piles with short bents*. The effect is one to make our architect friends weep.

British Columbia—Over the line in British Columbia it is indeed refreshing to see Vancouver "coming back." The slump wasn't caused by the war. Vancouver simply grew too fast, and in 1913 suffered from malnutrition—there wasn't enough incoming business to support her on the ambitious scale laid out. How does the recovery manifest itself? Well, take the electric-railway situation. The street cars are now carrying as many passengers as they did in the halcyon days (about 120,000 daily) and the company is making a short extension—an insignificant addition to the system, to be sure, but significant in that it is the first new construction required in five years or more.

It seems that the city has learned its lesson. Growth of a more steady and stable nature is indicated from now on. Despite the way conditions have improved of late, not a word is heard about the once proposed North Vancouver bridge or a tunnel under the first narrows. Rather the tendency is to foster industrial development and live within the assured income, so to speak. This is just as it should be.

British Columbia University, a $10,000,000 investment in the young people of the province, is making progress, and considerable work has been done on the attractive site out at Point Grey. Meantime the institution has been holding classes in temporary buildings within the city limits.

Over in the east end of Vancouver, two new and imposing railroad depots stand side by side. The Great Northern and the Canadian Northern lines have finally settled the question of where to locate their passenger terminals. The location is somewhat outside the present central zone of the city, to be sure, but it is easy to foresee that the city will soon grow around them. In fact, one has only to talk with H. J. Cambie, the white-haired consulting engineer of the Canadian Pacific Railway, to contrast the future Vancouver with the "Gas Town" of former days.

Our own vision, mind you, not Mr. Cambie's. He is too busy to speculate seriously in visions. Cambie is a fine example of the active practical engineer, and a mighty interesting character. It was he who located the Canadian Pacific main line across the Rockies in the early '80s. I missed him this trip. He wasn't in his office. Must be getting old, you say. He is. Somewhere past 80—84, I think—but you're wrong if you think he's out of the running.

I missed him because he was away on Vancouver Island *examining a new location in rough country!*

Nov. 4, 1919. SEATTLE.

An Analysis of the Esch Railway Bill

BY REPRESENTATIVE E. E. DENISON
of Illinois

The debate in the House of Representatives on the Esch bill developed the fact that Representative Denison of Illinois possessed a better grasp on the questions at issue than did most of his colleagues. He has prepared the following digest of the measure, especially for "Engineering News-Record."—EDITOR.

THE Esch bill that has passed the House provides for: (1) Immediate return of the railroads to their owners; (2) financing the railroads during the transition or reconstruction period; (3) tribunals for the voluntary adjustment and conciliation of labor disputes, and (4) amendment of the Interstate Commerce Act in numerous instances which are of great importance both to the railroads and to the country.

The bill does not embody any new or untried theories of railroad economics. It is based upon the fundamental principles of legislation and policies of Government heretofore provided, which gave the country the finest transportation system in the world. It continues rates established during Government control until changed in accordance with law by state tribunals or the Interstate Commerce Commission. It guarantees to the railroads, for a period of six months following their return, an income equal to the average railway earnings of the roads during the corresponding six months of the three years immediately prior to the war. It authorizes the President to make loans to the roads at 6% for a period of two years whenever such loans may be found to be necessary and provides for funding the amount which the railroads now owe to the Government.

The Government has lost about $650,000,000 in the operation of the roads during Government control. When the accounts between the railroads and the Government are settled according to the terms of the bill, the railroads will be indebted to the Government in the sum of about $775,000,000.

The total amount of the requirements for the railroads in the way of losses, loans and advances up to the time the roads shall be relinquished will amount to about $1,421,020,000, for which there has already been appropriated by Congress $1,250,000,000, leaving about $171,020,000 to be appropriated by Congress.

The bill appropriates $250,000,000 as a revolving fund out of which to make loans to the railroads if necessary. It amends the present Interstate Commerce Acts in practically all particulars recommended by the Interstate Commerce Commission as necessary or desirable in order to give the country an efficient and adequate transportation system. Among the important new provisions of the law under the Esch bill will be the following:

It authorizes the Interstate Commerce Commission to establish minimum as well as maximum rates.

It gives the Interstate Commerce Commission authority to supervise and approve all issuance of stocks and securities for railroad purposes.

It coördinates rail and water transportation by giving the Interstate Commerce Commission enlarged and extended powers to compel rail and water carriers to install water terminals.

It enlarges the powers of the Interstate Commerce Commission under the car-service act, and gives the commission plenary powers with reference to the distribution of cars and other facilities in cases of emergency and congestion of traffic.

It authorizes the commission to compel joint use of terminals when in the public interest.

It allows pooling of traffic and equipment, in the public interest.

It enacts into statute law the decision by the Supreme Court in the Shreveport case, by giving the commission the right to require readjustment of intrastate rates whenever they cause unjust discrimination.

It enlarges the commission to 11 members and increases the salary of a member to $12,000 per year.

It authorizes the commission to compel interstate carriers to furnish equipment or other facilities when needed in the public interest.

There are several provisions in the bill which are expressly intended to benefit the so-called weak roads or short lines, and these provisions will have the further tendency to promote voluntary consolidation of the weak lines or feeders with the trunk lines.

The House struck out of the bill the rule for ratemaking which had been recommended by the committee on interstate commerce, and which would have been of material benefit in the future rehabilitation of the railroads by strengthening their credit. As the bill finally passed, it leaves the powers of the Interstate Commerce Commission as to ratemaking as heretofore—namely, that all rates must be just and reasonable.

Proposed Water-Works Enlargements at Columbus, Ohio

THE $3,000,000 of water bonds authorized by the voters of Columbus, Ohio, Nov. 4, are to be used to increase the present storage capacity on the Scioto River so as to provide 55,000,000 gal. daily and to enlarge the purification and pumping works to supply 35,000,000 gal. daily, besides reinforcing the distribution system, all in accordance with a recent report by Prof. John H. Gregory, consulting engineer, Baltimore.

The safe daily yield of the Scioto River, with the storage provided by the present dam, is 24,000,000 gal. (or somewhat more with the flashboards recently provided), against a daily water consumption of 22,534,000 gal. in 1918. The per capita consumption in 1910, with 91.31% of the taps metered, was 75.4 gal., compared with 99.7 gal. in 1918 with 99.6% of the taps metered.

To provide 110 gal. per capita for 500,000 persons, or 55,000,000 gal. a day, would require 57,750,000 gal. of raw water, or a yearly total of 11,665,000,000 gal. Deducting 3,588,000,000 gal. for the total river flow that can be utilized without storage leaves 8,077,000,000 gal. to be provided by storage. The present Scioto River dam affords 1,487,000,000 gal. This would be increased to 2,244,000,000 gal. by raising the dam 6 ft., as proposed by Professor Gregory. A masonry dam 67 ft. high from the river bed to the spillway, located two miles north of Dublin, would give 5,833,000,000 gal. storage, thus making up the total storage required. Professor Gregory estimates that the old dam could be raised for $123,200; that the proposed Dublin dam would cost $1,250,700 and the Dublin reservoir, $635,000. Increasing the water-softening and filtration works by adding six 3,000,000-gal. filter units, and making associated extensions, would cost $297,000. New pumping equipment would require an outlay of $135,300, and to raise the intake dam would cost $5000. All this, with $550,000 to reinforce the distribution system, makes a total of $2,997,000.

Lowering a 400-Ton Dock Caisson Gate With Sand Jacks

Tests on Manipulation of Sand Jacks Led to Their Use in Placing Gate to Navy's Puget Sound Shipbuilding Dock

By G. W. Plaisted
Lieutenant, Corps of Civil Engineers, United States Navy, Puget Sound, Wash.

FEW records of the use of sand jacks are available. There are several instances where this type of jack has been used to lower arch forms instead of using drive wedges, and in some instances they have been used to lower bridge spans into final position. It is believed, however, that no attempt has ever been made to analyze the many advantages of sand jacks in lowering very heavy structures through comparatively great distances. It is the purpose of this article, in its primary object of describing the lowering of the 400-ton caisson gate of the new shipbuilding dock at the Puget Sound Navy Yard, first, to outline the fundamentals of the design of sand jacks; second, to prove the advantages of certain types; third, to determine within the limits of practical use the following factors: (a) The amount of settlement of sand upon application of a unit pressure for a given diameter and given height of jack; (b) The rate of flow of foundry quartz sand for a given-sized steel cylinder at a given unit pressure, the jack being equipped with four outlet holes of a given diameter; (c) The relation between the theoretical stress in the steel for a given size of jack and with a given unit load and the stress which actually occurs.

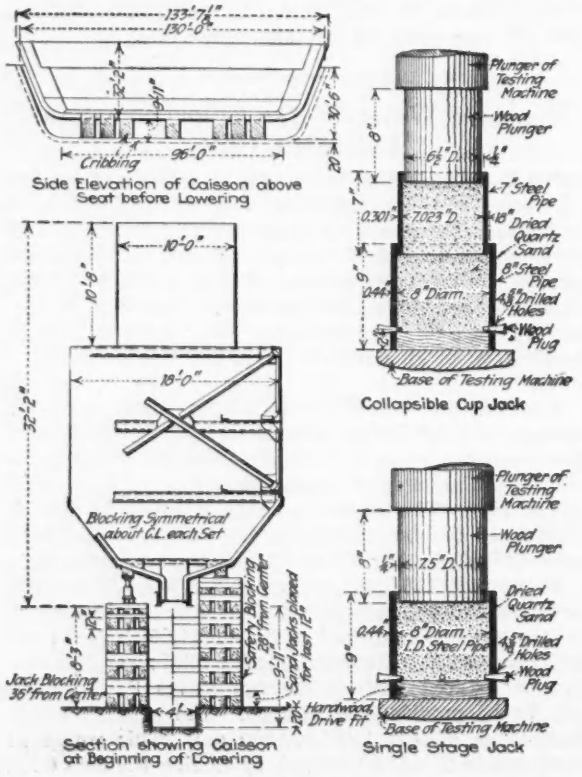


FIG. 1. 400-TON CAISSON TO BE LOWERED BY JACKS AND (ON RIGHT) DETAILS OF TEST JACKS

The general details of the caisson for dry dock No. 3, at the Puget Sound Navy Yard, when ready for lowering is shown in Fig. 1. The length of the upper deck is 133 ft. 7⅛ in.; the length of the base line 96 ft.; depth 32 ft. 2 in.; extreme width 18 ft.; total weight, ready for lowering, 400 tons.

The caisson was constructed on a series of blocking, and the base line in erection was 9 ft. 11 in. from the base line of the caisson seat. The only engineering problem in the lowering occurs from the point where the caisson is 12¾ in. from its final seat, as shown in Fig. 6. At this point it becomes necessary to use one of the following solutions:

1. To remove 12 in. of the concrete under the screw jacks, thus allowing the use of them for the final seat.
2. The use of two or more stages of drive wedges and blocking.
3. The substitution at the 12¾-in. point of short-stroke oil jacks for the screw jacks.
4. The use of some restrained material, such as sand, which can gradually be removed, thus lowering the caisson by displacement.

Each of the above possible solutions received proper consideration. The first was discarded as too expensive and as an improper and unsatisfactory engineering solution. The second depends too largely upon the personality feature in the driving of the wedges and the time element is also too great. A considerable amount of time was devoted to the consideration of the oil jack, and experiments were made with one of 50-ton capacity, with the following results:

The speed of lowering was found to be about ¼ in. per minute, and leakage around the piston upon the application of the load was excessive. This solution was therefore discarded on account of the inconvenience of operation of the jack and the unsatisfactory speed in lowering, and also on account of the expense of construction of sixteen 50-ton jacks, in comparison with the construction of sand jacks.

The many disadvantages of the above methods and the simplicity of operation of the sand jacks brought considerable favor to that solution, which was next considered.

The original type of sand jack submitted was designed on the basis of allowance of 6.2 tons per square foot, or 86.5 lb. per square inch pressure on the sand. The sand was to be relieved by the removal of consecutive sections of the sides from the top down.

This design was not sufficiently compact to insure proper operation, and the method of control of the sand was considered unsatisfactory. The original design of the restraining surface was made on the basis of complete transfer of equality of pressure. On this basis, an imposed pressure of 8 to 10 tons per square foot was the limit, using wood as the restraining material; above this pressure the side timbers become too unwieldy, and considerable difficulty is experienced in the design of the connections between the sides and the ends. The disadvantages of the wood sand jack were found to be (1) lack of compactness; (2) im-

proper method of control of sand, and (3) unnecessary expense of construction. These somewhat crude jacks, however, had very marked advantages over the first three methods as outlined above. These advantages were shortening of the time element, lessening of the cost element, and elimination in a large measure of the personal factor, which in such work is essential to assure proper operation.

The limit of vertical action of the sand jack is determined by the relation of the plunger to the length of the cylinder, as is evident from Fig. 6. In the lowering of this caisson two types of steel cylinder jacks were considered: First, the collapsible cup type, as shown in Fig. 1 at the top; and, second, the single-stage type jack as shown in Fig. 1 at the bottom.

A test collapsible-type jack was made up. The objects of the test were, primarily, to discover the proper

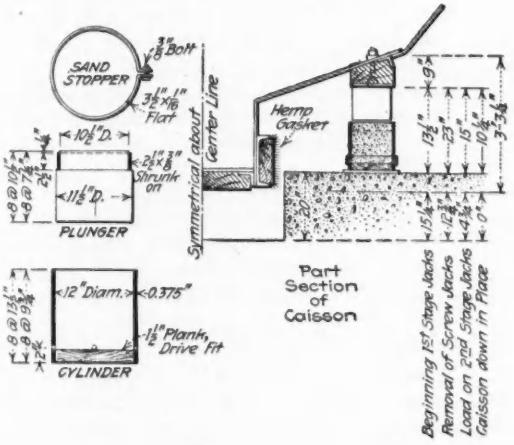


FIG. 2. DETAILS OF JACKS USED IN ACTUAL LOWERING

clearance between the plunger and the upper steel section and the clearance between the two steel sections. The general operation of the jack was satisfactory, and it was found that a clearance of $\frac{3}{16}$ in. on all sides gave satisfactory results. A slight amount of trouble was experienced in maintaining the proper relation of movement of the two parts of the cup, as compared with the plunger, and this type of jack was displaced by the single-stage jack, which eliminated one element of difficulty.

The method of operation of the single-stage jack, as shown in Fig. 1, is self-explanatory. A piece of 8-in. steel pipe was selected as the restraining surface, and the details of the resulting jack were used for test purposes. Loads varying from 14.4 tons per square foot (200 lb. per square inch), to 144 tons per square foot (2000 lb. per square inch) were applied, and the following factors noted for each load: (a) Rate of flow of sand, in inches per minute; (b) compression upon application of the load, in inches.

A table showing the results of this test is given at the top of the next column.

From the data as above given the following conclusions were drawn: First, the amount of settlement of the sand upon application of the load varies from $\frac{1}{4}$ in. with a unit pressure of 14.4 tons per square foot (200 lb. per square inch) to 1 in. with a unit pressure of 144 tons per square foot (2000 lb. per square inch); second, the rate of flow of foundry quartz sand with

TABLE SHOWING COMPARATIVE COMPRESSION AND RATE OF FLOW OF FOUNDRY QUARTZ SAND FOR UNIT PRESSURES VARYING FROM 200 POUNDS PER SQUARE INCH TO 2000 POUNDS PER SQUARE INCH—RESTRAINING SURFACE EIGHT-INCH STEEL PIPE

Unit Pressure in Pounds per Square Inch	Unit Pressure in Tons per Square Foot	Total Load in Pounds	Compression of Sand in Inches on Application of Load	Theoretical Tensile Stress in Steel in Pounds per Square Inch	Rate of Lowering in Inches per Minute
200	14.4	10,100	$\frac{1}{4}$	1,820	
400	28.8	20,200	$\frac{5}{16}$	3,640	
600	43.2	30,300	$\frac{3}{8}$	5,460	
700	50.4	35,400	$\frac{7}{16}$	6,370	
800	57.6	40,400	$\frac{1}{2}$	7,280	
900	64.8	45,600	$\frac{9}{16}$	8,190	
1,000	72.0	50,500	$\frac{5}{8}$	9,100	
1,200	86.4	60,600	$\frac{3}{4}$	10,920	
1,600	115.2	80,800	$\frac{7}{8}$	14,560	
2,000	114.0	101,000	1	18,200	

the cylinder as above described varies from $\frac{3}{4}$ in. per minute at 200 lb. per square inch to 1 in. per minute at 2000 lb.; third, at a pressure of 2000 lb. per square inch the theoretic tension in the steel shell is 18,200 lb. per square inch, yet the sand is easily controlled by a friction plug or by the finger. The above experiment was most satisfactory. The piece of 8-in. steel pipe gave a jack, of a satisfactory compactness, of 50-ton capacity, as shown by the accompanying table, under absolute control, and at practically no expense, while the amount of settlement upon application of the load was unexpectedly small.

At this point of the investigation the question arose in regard to the absence of pressure at the outlet holes for the sand. Theoretically, there was a pressure of 2000 lb. per square inch on the sand, and yet the flow of sand from a $\frac{3}{8}$-in. hole was stopped by the finger half turned. Obviously, at the holes at least there was not a pressure of 2000 lb. per square inch. In fact, the pressure was practically negligible in amount. The conclusions drawn were as follows: First, that the pressure on the sides of the cylinder is much less than the theoretical pressure due to the friction between the various particles of sand and the consequent transferral directly to the base of the cylinder; second, pressure at the holes is practically nothing, due not only to the reduced side pressure, as above described, but to constantly forming arches.

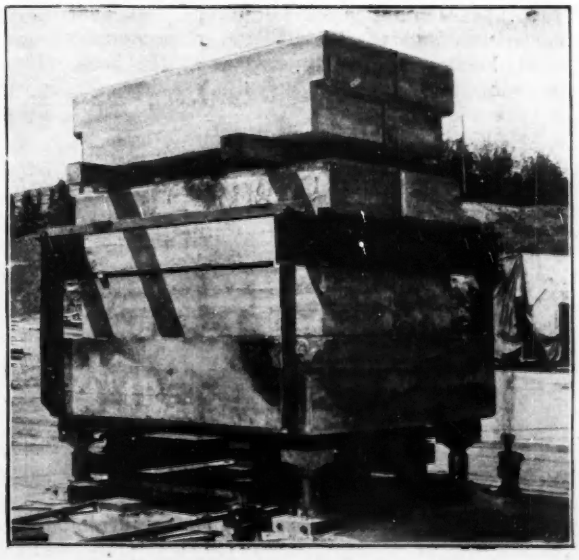


FIG. 3. SAND JACKS IN PLACE UNDER TEST LOAD

The following experiments were conducted with the major purpose of ascertaining within practical limits the ratio between the pressure as actually existing on the sides of the cylinder at a given unit pressure and the theoretical pressure, assuming the application of the hydraulic theory. A piece of annealed copper pipe, 7½-in. inside diameter, 0.095 in. thick, 8¾ in. in height, was subjected to a total load of 95,000 lb., with the purpose of determining the ratio as above noted, and also

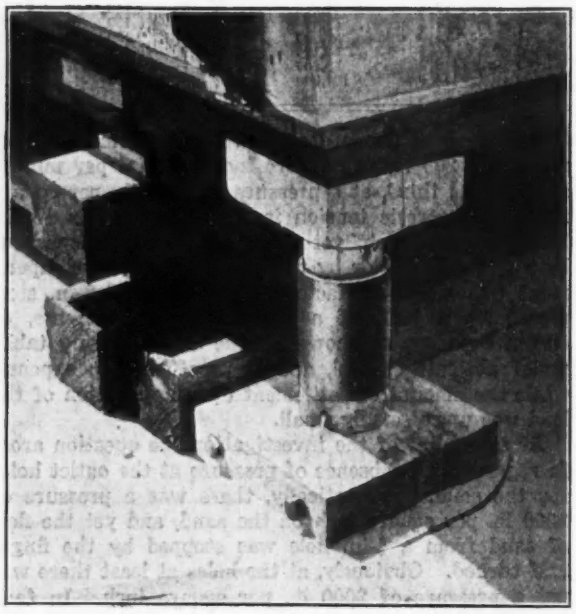


FIG. 4. CLOSE VIEW OF ONE OF THE TEST SAND JACKS

to make a study of the deformation curve of the cylinder at various pressures. Fig. 5 shows clearly the deformation curve at a total imposed load of 50,000 lb.; two inactive areas are shown, as expected, at the top and bottom, and practically uniform distribution of pressure on the sides of the cylinder. For greater loads than 50,000 lb. the cylinder assumes the general form as shown, Fig. 5, total load 70,000 lb.

The first conclusion drawn from the condition as shown was that the distribution of pressure was unequal, being considerably greater at the base. Upon removing the sand from the cylinders, however, it was noted that the inside was highly polished by sand friction, and the conclusion was drawn that the pressure was equally distributed, and that above the imposed load of 50,000 lb. the sand friction on the sides of the cylinder was sufficient to cause the jack to act as a column, giving telescopic failure as shown.

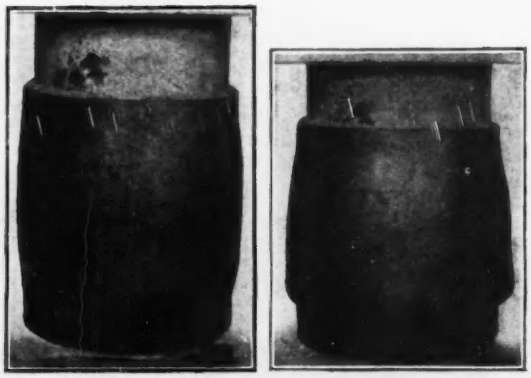


FIG. 5. DEFORMATION OF SAND-FILLED, ANNEALED COPPER PIPE, 7½ INCHES INSIDE DIAMETER; AT LEFT UNDER 50,000 POUNDS; AT RIGHT UNDER 70,000 POUNDS

A brass tube 6⅝ in. in height, 7½ in. inside diameter, 0.037 in. thick, was next tested, with lap-riveted joint. Five tests gave a total average load of 707,000 lb. necessary to disrupt the cylinders under sand pressure. As shown below, this gives a theoretic tension in the brass of 110,000 lb. per square inch. Actual tension test on five specimens gave an actual ultimate strength of 43,400 lb. per square inch. The factor, as determined by the above, is $110{,}000 \div 43{,}400 = 2.55$.

The calculations in detail are as follows:

Total force to disrupt $= 2\,S\,T\,H$

$$2\,S\,T\,H = pd\,h$$

S = Stress in tube in lb. per square inch.

T = Thickness of metal in inches.

H = Height in inches.

h = Distance in inches from bottom of plunger to top of plug.

p = Imposed vertical pressure in pounds per square inch.

d = Diameter of cylinder in inches.

Area of 7.5-in pipe = 442.2 sq.in.

$p = 70{,}000/44.2 = 1{,}590$ lb. per square inch.

$pdh = 1{,}590 \times 7.5 \times 4.5 = 53{,}700$ lb.

$2STH = 53{,}700 = 2S\ (0.037 \times 6.625)$

$$S = \frac{53{,}700}{2 \times 0.037 \times 6.625} = 110{,}000 \text{ lbs. per square inch}$$

(*theoretic*).

It is not considered practical to use the above factor in design of sand jacks. The actual capacity and design as given by the hydraulic theory is safe, and the material involved by such assumption is not extravagant. The results of the experiments conducted show that with the ordinary factor of safety of 4, in accordance with the hydraulic theory, an actual factor of 10 or thereabouts is secured.

The next question of interest in development of the method of lowering the 400-ton caisson into position was the organization of the labor force and the coördination of all elements to secure equal lowering at each corner, thus insuring the safety of the operating force. In view of the importance of satisfactory operation, it was considered essential to duplicate as nearly as possible the conditions of lowering the caisson, and actually to lower some other comparatively heavy weight with similar equipment. At this time the counterweights for the four hammerhead cranes for the new shipbuilding dock had been completed, and sufficient of them were selected to make a total imposed load of 98,280 lb. The test was conducted in the following manner: One screw jack was placed at each corner of the counterweights and one sand jack at each corner, just outside of the screw jacks, as shown in Fig. 3. No weight was superimposed on the sand jacks at the beginning of the test; the load was supported entirely by the screw jacks. The steel cylinders were filled absolutely full, and the bottom of the pistons at the beginning of the test were at the same level as the top of the steel cylinder. At this point in the test the weight was gradually placed upon the sand jacks by lowering the screw jacks. The sand showed a compression of ⅜ in. uniformly at all corners before the weight was entirely sustained by the sand

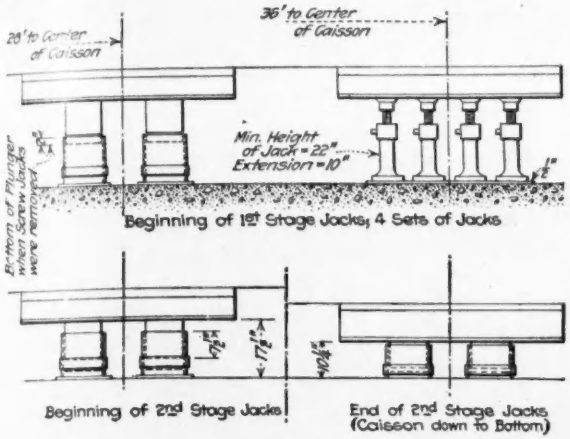

28' to Center of Caisson
36' to Center of Caisson
Min. Height of Jack = 22"
Extension = 10"
Beginning of 1st Stage Jacks, 4 Sets of Jacks
Beginning of 2nd Stage Jacks
End of 2nd Stage Jacks (Caisson down to Bottom)

FIG. 6. DETAILS OF LAYOUT OF SAND JACKS USED TO LOWER 400-TON CAISSON

jacks, leaving the screw jacks loose. From this point the screw jacks were used simply as a safety device to follow the sand jacks in lowering. All plugs were loosened, but not withdrawn. Two men were stationed at each corner, one in control of the screw jacks and one in control of the sand jacks. The signal to pull the sand jack plugs was a single whistle; and to replace at the end of an interval of test there was given the same signal. Plugs were withdrawn and sand was allowed to flow for two minutes.

The readings at the end of this time at the four corners, were $2\frac{1}{4}$ in., $2\frac{3}{8}$ in., $2\frac{3}{4}$ in. and $2\frac{3}{8}$ in. The discrepancy at the corner reading $2\frac{3}{4}$ in. was caused by a slight sticking of the screw jack on the opposite corner, which did not allow the sand jack to settle into position in accordance with the flow which had taken place. The ease of leveling up sand jacks under conditions as just cited was shown when the screw jack on the corner which had gone down too far was elevated sufficiently to take the weight at that point, while the men at the other three corners were notified to plug in until a reading of $2\frac{3}{4}$ in. was obtained. This was done, and the apparatus was again in equilibrium for a second test run. The time consumed in the lowering of the counterweights 2 in. was exactly two minutes.

The third stage of the test was conducted with the object of running all jacks to a reading of 8 in. The first corner reached 8 in. four minutes after the start, having traveled in this period of the test $5\frac{1}{4}$ in. An average rate of flow, or rate of lowering of the counterweights throughout this period, as well as throughout the first part of the test, was 1 in. per minute. The results of the above experiment substantiated in general previous experiments made on the testing machine, and the actual practical operation of sand jacks was pronounced successful. The use of the single-stage steel-cylinder sand jack was finally adopted as the proper method of lowering the caisson to final seat.

Fig. 1 shows the method of lowering by screw jacks and auxiliary blocking to the level of the first-stage sand-jack operation. This period of lowering the caisson passed without event. A level was mounted on the platform of an adjacent piledriver, just east of the caisson, and throughout the lowering the readings were taken to maintain the same elevation on the four corners.

The caisson seat was extended by a temporary timber structure, so that no movement of the caisson laterally during lowering was possible. There was a sufficient leakage through the cofferdam to cause overflow of the caisson seat, thus endangering wetting of the sand in the sand jacks. To prevent this possibility, galvanized-iron pans, as shown in Fig. 7, were employed, and satisfactory operation under the existing conditions was assured. The operation of the jacks was in general exactly as was expected. The penetration upon application of total load on the sand jacks was about $\frac{3}{4}$ in. and the speed of lowering was about $\frac{3}{4}$ in. per minute. The method in general proved inexpensive, simple of operation and absolutely safe.

From the tests conducted, and from the experience

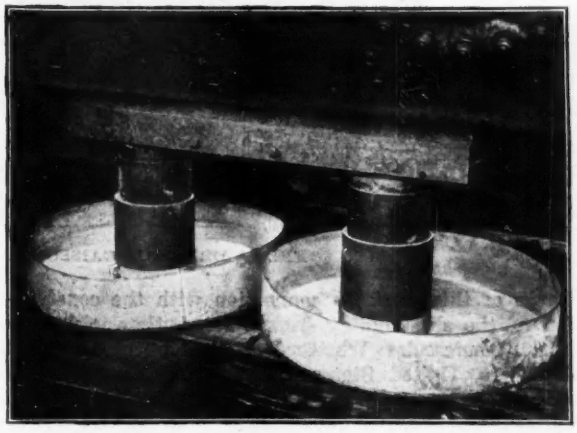


FIG. 7. SAND JACKS IN POSITION BENEATH CAISSON

of actual lowering of the 400-ton caisson, the following conclusions were drawn:

1. Sand jacks are applicable not only under conditions similar to those in lowering the caisson as above outlined but in lowering all heavy weights.

2. They are absolutely dependable and simple of operation.

3. Their speed of operation is greater than the ordinary beveled-gear jack.

4. Their cost is negligible.

5. In all cases where the operation of lowering the object in question is similar to that above described, allow 1 in. for safety for settlement upon application of load up to 200 lb. per square inch and 2 in. additional to follow sand jacks with screw jacks before the removal of screw jacks.

6. The following table is recommended for practical use to ascertain the relation between the size of outlet hole and the size of the cylinder for a pressure of 1000 lb. per square inch, and for a speed of lowering of 1 in. per minute, as well as the capacities of various sizes of jacks:

Size of S.S. W. I. Steam, In.	Diameter of Outlet Holes, In.	Capacity of Jack at 1000-Lb. Pressure, Ton	Theoretic Stress in Steel, Lb. Sq.In.
6	$\frac{1}{2}$	15	10,700
8	$\frac{3}{4}$	25	12,400
10	$1\frac{1}{4}$	40	13,600
12	$1\frac{3}{4}$	58	16,000

The investigations in connection with the final development of the sand jacks used in the lowering of the caisson were conducted under the direct and personal supervision of the author, at the original suggestion of Capt. L. E. Gregory, Corps of Civil Engineers, United States Navy, public works officer, who was in general

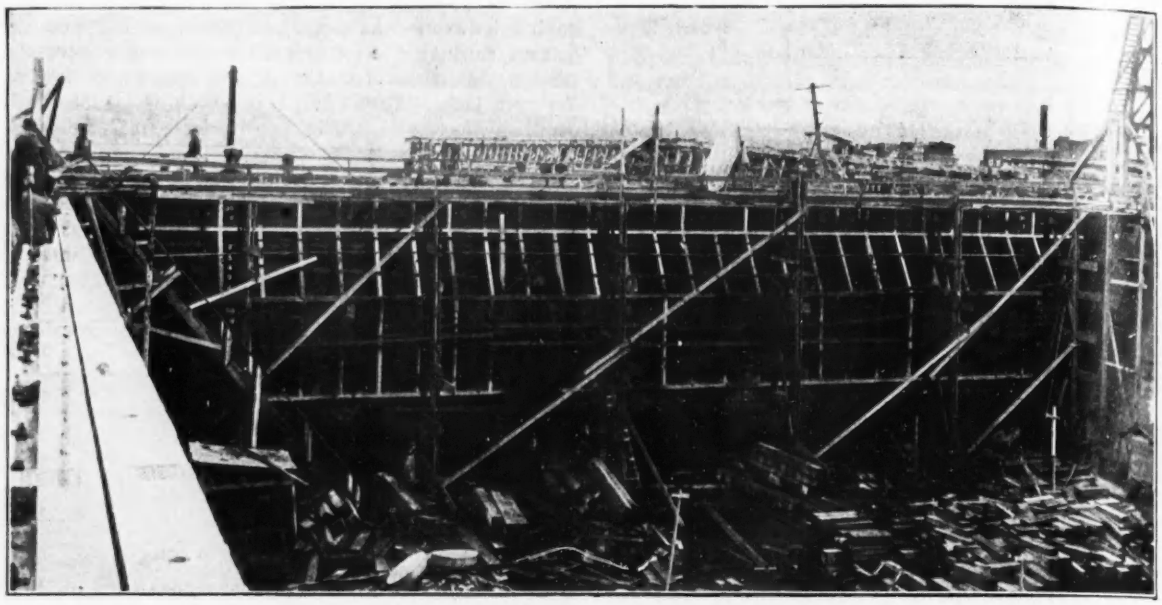


FIG. 8. DRY-DOCK CAISSON AS IT WAS LOWERED INTO PLACE

charge of this work, in connection with the construction of the shipbuilding dock. The author wishes to thank Commander Whitford Drake, Corps of Civil Engineers, United States Navy, for several valuable suggestions, as well as H. A. Sylvester and V. E. Hulteen, who assisted personally.

Transitory Protection Measures Asked By French Railroads

BECAUSE they feel unable to return to normal running conditions prevalent in times of peace without first recruiting a full operating staff, reconstituting their material and rolling stock, and adapting themselves to the new difficulties which have recently arisen, the French railroads are asking the Minister of Public Works that a certain number of measures in force during the control of railroad lines by the Government be retained when the transition from Federal to private control takes place upon a Presidential decree that a state of war has ceased to exist.

The railroad administrations are not claiming a prompt return to entire liberty of action, says a report from Consul General Thackara, in Paris, but they ask for the maintenance of a certain number of regulations at present in force and particularly those respecting priority of transportation for certain essential products. They also ask that the regulations governing delivery of goods be modified to a certain degree.

In accordance with these requests, the Minister of Public Works has prepared a decree making various modifications in the regulations for the working of French railroads between the date of cessation of hostilities and Dec. 31, 1920. The decree was signed by the President of France, Oct. 15, 1919. The following are some of the more important provisions of this decree:

The principal railroads must give priority in the following cases: (a) To the transportation of goods destined for the reconstitution of the liberated regions, along the lines of the program laid down by the Ministry for the Liberated Regions; (b) to slow freight in carload lots along the lines recommended by the Ministeries of Revictualing and Industrial Reconstitution in regard to the supply of fuel and revictualing of the whole country.

A provisional committee will be formed to decide upon the necessary measures to insure the proper compliance with these provisions and the satisfactory working of the great railroad systems. Its decisions are final and obligatory for all the systems.

Another committee will be appointed to deal with questions relating to railroad supplies and rolling stock, and to coördinate the action of the railroads in respect to such matters.

This latter committee will include among its members three manufacturers of railroad material designed by the Ministry of Public Works. Its decisions are final, with the exception of measures relating to closing stations, suppression of trains, or limiting shipments. In such cases its decisions are subject to revision by the ministry.

Hydro-electric Work in Ontario

In addition to the huge Queenston-Chippawa power project which will develop 350,000 to 400,000 hp. at Niagara, the Hydro-electric Power Commission of Ontario has several other projects under way. The largest of these is the Nipigon River project, at a point about 60 miles northeast of Port Arthur, where 72,500 hp. are being developed. Six 12,500-hp. units will eventually be installed. At High Falls, on the Mississippi River (which is not "the Father of Waters," but a small stream in eastern Ontario) there are being developed 3000 hp. in three equal units, and near Owen Sound, on the Eugenia Falls plant, an extension of one 4000-hp. unit is being made to the two 4000-hp. units already installed. This is the highest-head turbine in Canada, with a head of 550 ft. The chief engineer of the commission is F. A. Gaby of Toronto.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Teaching Engineering English by Example

ENGINEERING EDUCATION: Essays for English Selected and Edited by Ray Palmer Baker, M.A., Ph.D., Professor of English in the Rensselaer Polytechnic Institute. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5 x 8 in.; pp. 185.

Three features, "largely original," are claimed by the author for this volume of selections for use in elementary courses in exposition for engineering students: (1) Character; (2) authoritativeness and (3) arrangement of the selections. The essays and addresses are recent and are calculated to appeal to the student. They are all written by technical men. They are so arranged as to "present an ideal of engineering education which cannot be found elsewhere." The selections fall in three groups, having to do with the origins, the types and the bases of engineering education. Under origins we have Simon Newcomb on the "Evolution of the Scientific Investigator" and J. J. Thomson on "The Relation of Pure Science to Engineering." Under types, J. B. Johnson's "Two Kinds of Education for Engineers" and Howard McClenahan's "The Classical-Scientific vs. the Purely Technical Engineering Course" are presented. Under bases there are five pairs of essays dealing with language, mathematics, physics, chemistry and imagination. Of these specific mention may be made of "The Value of English to the Technical Man," by John Lyle Harrington; "The Value of Classics in Engineering Education," by Charles Proteus Steinmetz (see *Engineering Record* of Aug. 9, 1913, p. 158); and "The Imaginative Faculty in Engineering," by Isham Randolph. Most, if not all, of the selections have been abridged by the editor. Each is not only well chosen for its primary purpose of use in engineering schools but might also be read, or read anew, by engineers in practice.

Use of Southern Yellow Pine

SOUTHERN YELLOW PINE: A Manual of Standard Wood Construction—New Orleans, La.; Southern Yellow Pine Association. Cloth; 5 x 7 in.; pp. 136; illustrated.

While there is no substantial difference between this and the preceding (sixth) edition of "Standard Wood Construction," it may be pointed out that the book is a compilation of tables analogous to those of the rolling-mill handbooks and should prove just as necessary to the designer in wood as do the latter to the designer in steel. Nominally, the tables and information apply only to yellow pine, but as the beam tables, which make up a large part of the whole, are figured for various fiber stresses from 1200 to 1800 lb. per square inch, the book should be adaptable to most structural woods.

Against Socialism

SOCIALISM AND AMERICAN IDEALS—By William Starr Myers, Ph.D., Professor of Politics, Princeton University. Princeton, N. J.: Princeton University Press. London: Humphrey Milford, Oxford University Press. Cloth; 5 x 8 in.; pp. 89.

Un-American, undemocratic and in conflict with the tenets of both the Christian and Jewish religions, is Professor Myers' opinion of Socialism. He defines Socialism as "collective ownership (exerted through the government or society as politically organized) of the means of production of all forms of wealth." Otherwise stated, "Socialism means the substitution of governmental judgment for that of the individual and for individual ambition as well." The book is a reprinting of articles contributed at intervals to the New York *Journal of Commerce and Commercial Bulletin*. Although other writers have made a more coherent and forcible case against Socialism, Professor Myers' little book will doubtless be welcomed by many as a more recent statement of the subject.

Astronomy for Surveyors

THE ELEMENTS OF ASTRONOMY FOR SURVEYORS—By R. W. Chapman, M.A., B.C.E., F.R.A.S., Professor of Mathematics and Mechanics in the University of Adelaide. London: Charles Griffin & Co., Ltd. Philadelphia, Pa.: J. B. Lippincott Co. Cloth; 5 x 8 in.; pp. 247; illustrated

REVIEWED BY HECTOR JAMES HUGHES

Professor of Civil Engineering, the Harvard Engineering School of Harvard University, Cambridge, Mass.

Astronomy to the extent ordinarily assumed to be prescribed for students of engineering is covered in this book; and it has been treated from the standpoint of the engineer. Actually, its scope extends somewhat beyond the subject matter contained in the chapters on astronomy usually given in textbooks on surveying, and falls somewhat short of the treatment given in books on geodesy or higher surveying. Such astronomical observations as can be made by the use of surveying instruments are treated concisely and clearly; and the methods of making the necessary reductions are explained in every case with worked-out problems for the purpose of illustration or guidance. The degree of precision that should be attained in the observation, and is to be expected from the resulting computations, is indicated definitely and simply.

The author, like many other teachers and some students, evidently objects to the prevailing rule-of-thumb methods commonly used in teaching this subject, and believes that students should understand what they are doing. Usually it is difficult to insure this without too much elaboration, but the reviewer, looking at the book from the standpoint of an engineer who does not know much about astronomy, is of the opinion that the author has succeeded in making the fundamental astronomical phenomena unusually clear.

There is no royal road to the understanding of astronomy, and in an engineering school one of two methods must be followed. Either the subject must be treated with the utmost brevity and by the use of computation forms, with the expectation that only a few students will understand the work, or else a fairly comprehensive treatment of astronomy must be given. The former method is usually followed, chiefly because there is not time for more; and for the majority of engineers such procedure serves the necessary purpose. In many instances, however, students who have had only the minimum amount of instruction in the subject frequently have, in practice, to make astronomical observations of a simple character, and are not satisfied

to proceed without understanding the processes. For such men, and for schools that can give sufficient time to the subject, the book will well serve a useful purpose. It is a simple, straightforward, excellent, brief text on exactly what it claims to be, namely, a course in astronomy for surveyors, and the reviewer thinks it is worthy the consideration of those who have need for such a book.

For Automobile Owners and Drivers

THE GASOLINE AUTOMOBILE: Prepared in the Extension Division of the University of Wisconsin by George W. Hobbs, B.S., and Ben G. Elliott, M.E. Second Edition, Completely Revised and Rewritten by Ben G. Elliott, M.E., Assistant Professor of Mechanical Engineering, The University of Wisconsin, and Earl L. Consoliver, M.E., Assistant Professor of Mechanical Engineering, The University of Wisconsin. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth; 6 x 9 in.; pp. 483; illustrated.

Based largely on a series of lectures given in 23 cities of Wisconsin in the winter of 1914-15, this book was first published in 1915 as a volume of 10 chapters (reviewed in *Engineering News* of Feb. 17, 1916, p. 322). The volume is now nearly double the size of the first edition. It contains entirely new chapters on "Principles of Electricity and Magnetism," "The Automobile Storage Battery," and "Wheels, Rims and Tires," and in addition, portions of the chapters in the original editions have been expanded into separate chapters. The book has been rewritten. The 544 carefully selected and presented illustrations add materially to the clearness of the presentation of the subject.

"Hydraulics" by Daugherty, Second Edition

HYDRAULICS—By R. L. Daugherty, A. B., M. E., Professor of Hydraulic Engineering, Rensselaer Polytechnic Institute, Etc. Second Edition, Revised and Enlarged. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth: 6 x 9 in.; pp. 267; illustrated.

New material in this edition "consists principally of graphical methods of solving certain practical problems, the determination of the economic size of pipe, and problems of flow through compound pipes, branching pipes, pipes with laterals, and through rotating channels." Extensions have been made elsewhere and some portions have been rewritten "for greater effectiveness." The first edition was favorably noticed by Robert E. Horton in *Engineering News* of July 20, 1916, and by A. G. Hillberg in *Engineering Record* of July 22, 1916. Mr. Horton characterized the volume as "primarily a textbook for use in engineering schools where the time that may be devoted to hydraulics proper, aside from its applications, is rather limited."

Report on the Chinese Railways

STATISTICS OF GOVERNMENT RAILWAYS IN CHINA, 1917—Report to the Ministry of Communication, Department of Railways. Peking, China: The Minister. Paper; 9 x 13 in.; pp. 133; illustrated.

This report for the calendar year 1917 covers only the Government railways, including 14 separate lines. These, with branches and some private lines, make 4350 miles under control of the Ministry of Communications, while other lines operated under concessions bring the grand total of railways in China to 6740 miles. Operating methods, conditions and results are dealt with in 74 pages, the balance of the report consisting of statistical tables and diagrams.

The accounts of the Government lines are based upon a uniform classification which became effective in January, 1915, and follows the general principles of accounting adopted in other countries. Metric and British systems of weights and measures are used by different lines, but all distances are converted into kilometers. The two ton weights, however, are so nearly alike that no conversion has been thought necessary for such general figures as are given in the report. The terminology is English rather than American.

It is pointed out that China's extensive waterways will always serve to keep low the railway mileage per unit of area and population, but that, on the other hand, railways tend to become more and more an integral part of the industrial machinery of the nation. The equipment is relatively small, comprising only 648 locomotives, 1315 passenger cars and 10,659 freight cars, but many freight cars are uesd also for passenger service. Operating expenses represent nearly 90% of operating revenues.

Garden Cities and Back to the Land

NEW TOWNS AFTER THE WAR: An Argument for Garden Cities—By New Townsmen. London, Eng.: J. M. Dent & Sons, Ltd. Paper; 5 x 7 in.; pp. 84.

Assuming that England needs a million houses at once and a hundred thousand yearly, that both urban and rural districts share in the need, that a new sort of town, better suited to industry and home life, is needed, and that encouragement should be given to agriculture, the authors propose the creation of a large number of garden cities. Towns of 30,000 to 50,000, surrounded by belts of open land reserved for farming, are advocated. Some of the arguments in support of garden cities are perhaps as applicable to America as to England, but, badly as we need better housing facilities here, the need is nothing like as acute as it is in England.

New Publication on Labor Conditions

A new weekly publication, beginning with the issue of Oct. 18, 1919, has been issued by Bloomfield's Labor Digest, 6 Beacon St., Boston, Mass., under the title *Industrial Relations*. It contains reports of current labor events in the United States and other countries, including a review of labor activities, industrial relations, wage and hour movements, a summary of the contents of the radical press and the trade union press, foreign labor news, and charts analyzing plans and methods in operation for promoting industrial relations. The new publication is issued as a "service" and not as a regular periodical. It is furnished in letter size in convenient form for loose-leaf binding.

Press Bulletin Service on Public Health

A press bulletin service, to supply weekly news stories and articles of information on public health, hygiene and sanitation, has been established by the department of hygiene and public health of the University of Illinois, Urbana. It is expected that the material will be used by the newspapers of Illinois in a health advice column.

Budget Promotion

A four-page publication entitled *The National Budget* is being issued at Washington, D. C., by the National Budget Committee. The New York offices of the committee are at 109 Liberty Street.

PUBLICATIONS RECEIVED

Under a Postoffice Department ruling made applicable to *Engineering News-Record* in July, 1919, it is no longer possible to give the prices of new publications announced under this head or of books reviewed in the preceding columns. Readers will therefore have to obtain this information as best they can. Most of the public documents and of the pamphlets announced may be obtained free on application, or at least by paying postage. So far as possible, the name and address of the publisher of each book and pamphlet are given in each entry.

AMERICAN SOCIETY FOR TESTING MATERIALS: Standards and Tentative Standards, 1919—Philadelphia, Penn.: The Society. Paper, 6 x 9 in.; pp. 63; illustrated.

APPRAISALS AND RATEMAKING—By Cecil F. Elmes, of the Sanderson & Porter Engineering Staff. New York, Chicago, San Francisco: Sanderson & Porter. Paper; 8 x 11 in.; pp. 25; illustrated.

CHEMICAL AND BACTERIOLOGICAL EXAMINATION OF the London Waters: Report for 1918-19—By Sir Alexander Houston, Director of Water Examination, Metropolitan Water Board. London, Eng.: The Board. Paper; 8 x 13 in.; pp. 30; illustrated.

COAL IN 1917: PART A, PRODUCTION—By C. E. Lesher. Washington, D. C.: U. S. Geological Survey. Paper; 6 x 9 in.; pp. 146; illustrated.

COKE AND BY-PRODUCTS IN 1916 AND 1917—By C. E. Lesher and W. T. Thom, Jr. Washington, D. C.: U. S. Geological Survey. Paper; 6 x 9 in.; pp. 64; illustrated.

COST KEEPING AND CONSTRUCTION ACCOUNTING: Adapted to any Work Consisting of Numerous Items, Department or Divisions on which Detailed Unit Costs are Desired—By G. Ed. Ross, Associate Member, Northwest Society Highway Engineers. Second Edition. Salem, Ore.: The Ross System Co. Cloth; 5 x 8 in.; pp. 171; illustrated.

DEVELOPMENT OF IRON ORE INTO IRON AND STEEL—By S. C. Dickerhoff, Jr. Bethlehem, Penn.: The Author. Chart; 22 x 13 in.

ELECTROLYSIS IN CONCRETE—By E. B. Rosa, Chief Physicist; Burton McCollum, Associate Physicist; and O. S. Peters, Assistant Physicist, Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 18. Washington, D. C.: The Bureau. Paper; 7 x 10 in.; pp. 142; illustrated. 35c. from Superintendent of Documents.

THE ENGINEER SCHOOL AT CAMP HUMPHREYS: A Report on Methods of Teaching Engineering—Washington, D. C.: War Department Committee on Education and Special Training. Paper; 6 x 9 in.; pp. 76.

ENGINEERING PROBLEMS OF REGIONAL PLANNING—By Morris Knowles, Chief Engineer, Housing Department, Emergency Fleet Corporation, United States Shipping Board. Pittsburgh, Penn.: The Author. Paper; 6 x 9 in.; pp. 24.

FINAL REPORT OF THE INTERNATIONAL JOINT COMMISsion on the Lake of the Woods Reference. Washington, D. C.: The Commission. Cloth; 7 x 10 in.; pp. 261; illustrated.

FINANCIAL STATISTICS OF STATES, 1918. Washington, D. C.: Bureau of the Census. Cloth; 9 x 12 in.; pp. 123.

GROUND WATER IN THE SAN JACINTO AND TEMECULA Basins, California—By Gerald A. Waring. Prepared in Coöperation with the Department of Engineering of the State of California. Washington, D. C.: U. S. Geological Survey. Paper; 6 x 9 in.; pp. 113; illustrated. 40c. from Superintendent of Documents.

THE HEALTH OFFICER—By Frank Overton, A. M., M. D., D. P. H., Sanitary Supervisor, New York State Department of Health, and Willard J. Denno, A. B., M. D., D. P. H., Medical Director of the Standard Oil Co., formerly Secretary, New York State Department of Health. Philadelphia and London: W. B. Saunders Co. Cloth; 6 x 9 in.; pp. 512; illustrated.

HUMAN RELATIONS IN INDUSTRY: A Clarification of the Principles and Factors Involved. Chicago, Ill. L. V. Estes, Inc. Paper; 4 x 7 in.; pp. 15; illustrated.

HYDROLOGY: The Fundamental Basis of Hydraulic Engineering—By Daniel W. Mead, M. Am. Soc. C. E., Consulting Engineer, Professor of Hydraulic and Sanitary Engineering, University of Wisconsin. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth; 6 x 9 in.; pp. 647; illustrated.

IRON-DEPOSITING BACTERIA AND THEIR GEOLOGIC RElations—By Edmund Cecil Harder. Washington, D. C.: U. S. Geological Survey. Paper; 9 x 11 in.; pp. 89; illustrated. 25c. from Superintendent of Documents.

Crenothrix and some other bacteria of interest to the water and sewage specialist are considered in this paper, but with no direct, practical conclusions. The studies were made largely in the bacteriological laboratory of the Agricultural Experiment Station, University of Wisconsin, Madison.

MANUAL OF INSTRUCTIONS TO DEPARTMENT EMPLOYees: Oregon State Highway Department, 1919—By Herbert Nunn, State Highway Engineer. Salem, Ore.: The Department. Paper; 5 x 7 in.; pp. 107.

Instructions given in nearly every phase of the highway employee's work, including general reports, attention to state equipment, auditing claims, preparation of payrolls and expense accounts; cost keeping, survey methods, mapping and general construction work. Interesting to supervising highway engineers as a guide in preparing similar instructions.

LES METHODES MODERNES DE LA RESISTANCE DES Materaux—By Bertrand de Fontviolant, Professeur a l'Ecole Central des Arts et Manufactures. Paris, France: Gauthier-Villars et Cie. Paper; 7 x 10 in.; pp. 82.

MINERAL RESOURCES OF THE UNITED STATES: Preliminary Report, 1918; Introduction by Edson S. Bastin; Statistics Assembled by Martha B. Clark from Data Furnished by Specialists of the Division of Mineral Resources. Washington, D. C.: U. S. Geological Survey. Paper; 6 x 9 in.; pp. 106.

NATURAL GAS AND NATURAL-GAS GASOLINE IN 1917—By John D. Northrop. Washington, D. C.; U. S. Geological Survey. Paper; 6 x 9 in.; pp. 85; illustrated.

THE NEW SEWAGE-TREATMENT PLANT AT MONTEZUMA, Iowa—By J. H. Dunlap, Associate Professor of Hydraulics and Sanitary Engineering, College of Applied Science, State University of Iowa, Iowa City: The Author. Paper; 6 x 9 in.; pp. 19; illustrated.

Description of an Imhoff tank, a siphon chamber, a sand filter and sludge beds for a future estimated population of 2,000. Conditions determining amount of bonds legally permitted are reviewed, and unit cost data are given.

NEW SOUTH WALES GOVERNMENT RAILWAYS AND TRAMways: Report of the Railway Commissioners for the Year Ended June 30, 1919. Sidney, N. S. W.: The Railway Commissioners. Paper; 8 x 13 in.; pp. 92; illustrated.

That this report was issued within about two months after the close of the period which it covers is commendable. It records progress and conditions as well as statistics. Freight rates were increased about 27½% in November, 1918, owing to the rise in wages and cost of materials.

OIL PIPE LINES OF THE YARHOLA PIPE LINE CO.: Oklahoma Oil Fields to East St. Louis, Ill. New York: Sanderson & Porter. Paper; 8 x 11 in.; pp. 17; illustrated.

Describes construction of a long pipe line, and outlines Diesel engine pumping equipment.

THE OKLAHOMA PUBLIC-HEALTH SURVEYS: Oklahoma City—By Murray P. Horowitz, M. S., Department of Biology & Public Health, Massachusetts Institute of Technology; Jules Shevitz, B. S., General Secretary, Oklahoma Tuberculosis Association. Oklahoma City, Okla.: The Association. Paper; 6 x 9 in.; pp. 155; illustrated.

A comprehensive survey, including water-supply, sewerage, and garbage and refuse disposal. The field work was done in June, 1918.

OREGON STATE HIGHWAY DEPARTMENT: Important Statutes Compiled in April, 1919. Salem, Ore.: The Department. Paper; 6 x 9 in.; pp. 80.

PRECAUTIONS AGAINST FREEZING OF FIRE-EXTINGUISHing Appliances. Boston, Mass.: National Fire Protection Association. Paper; 8 x 11 in.; pp. 3.

PRICES OF IRON, STEEL AND THEIR PRODUCTS—By Walter W. Stewart. Washington, D. C.: War Industries Board. Paper; 6 x 9 in.; pp. 46; illustrated.

PROBLEMS IN PHYSICS: Derived from Military Situations and Experience. Washington, D. C.: War Department, Committee on Education and Special Training. Paper; 6 x 9 in.; pp. 154; illustrated.

REPORT ON HOUSING: Including Act, Rules and Regulations, Housing Standards, Provisions to be Considered, and Forms. Toronto, Can.: Bureau of Municipal Affairs. Paper; 6 x 9 in.; pp. 134.

ROAD-MATERIAL SURVEYS IN THE CITY AND DISTRICT of Montreal, Que.—By Henry Gauthier. Ottawa, Can.: Geological Survey. Paper; 7 x 10 in.; pp. 52; illustrated.

SCIENCE REPORTS OF THE TOHOKU IMPERIAL UNIVERsity, Vol. VIII, No. 2. Contents: On the Analytic Function of z-x-yi, Whose Modulus is a Rational Integral Function of x and y; On Characteristic Properties of the Conic and Quadric; On the influence of Manganese on the Physical Properties of Carbon Steels; On Some Physical Constants of Tungsten Steels; On the Variation of the Specific Heat During Melting and the Heat of Fusion of Some Metals. Tokyo, Japan: Maruzen Co., Ltd. Paper; 7 x 10 in.; pp. 52; illustrated.

STORAGE BATTERIES FOR TRUCKS: A Job-Sheet Manual. Washington, D. C.: War Department Committee on Education and Special Training. Paper; 6 x 9 in.; pp. 82.

SURFACE WATER SUPPLY OF HAWAII, 1918—By Nathan C. Grover, Chief Hydraulic Engineer, and C. T. Bailey, Acting District Engineer. Prepared in Coöperation with the Territory of Hawaii. Washington, D. C.: U. S. Geological Survey. Paper; 6 x 9 in.; pp. 172. 15c. from Superintendent of Documents.

SURVEYING: With Sections on Map Reading, Military Sketching and Topographic Drawing. Washington, D. C.: War Department Committee on Education and Special Training. Paper; 8 x 11 in.; illustrated.

TECHNICAL BOOKS OF 1918: Compiled by Donald Hendry, Head of the Applied Science Reference Department, Pratt Institute Free Library, Brooklyn, N. Y.: The Institute. Paper; 5 x 7 in.; pp. 28.

TECHNO-CHEMICAL RECEIPT BOOK: Containing Several Thousand Receipts and Processes, Covering the Latest, Most Important and Most Useful Discoveries in Chemical Technology and Their Practical Application in the Arts and the Industries—Compiled and Edited by William T. Brannt, Author of "Metallic Alloys," Etc., and William H. Wahl, Ph. D., Author of "Galvanoplastic Manipulations." Philadelphia: Henry Carey Baird & Co. Inc. Cloth; 5 x 7 in.; pp. 516; illustrated.

TRAINING COURSES IN SAFETY AND HYGIENE IN THE Building Trades: Issued by the Federal Board for Vocational Education. Trade and Industrial Series No. 6. Washington, D. C.: The Board. Paper; 6 x 9 in.; pp. 127; illustrated.

USE AND WASTE OF IRRIGATION WATER—By G. E. P. Smith. Tucson, Ariz: Agricultural Experiment Station. Paper; 6 x 9 in.; pp. 16; illustrated.

THE WEATHER AND DAILY STREAM FLOW FOR HYDROElectric Plants—By Cecil Alter. Reprinted from *Monthly Weather Review*, May, 1919. Washington, D. C., Weather Bureau. Paper; 9 x 12 in.; pp. 3.

ZONING AND CITY PLANNING FOR PORTLAND, OREGON—By Charles H. Cheney, Consultant, City Planning Commission. Portland, Ore.: The Commission. Paper; 6 x 9 in.; pp. 55; illustrated.

SOCIETY SERVICE

A Section Dealing with the Results of Teamwork by Technical Men

Local Council Idea Spreads on Pacific Coast

In each of six centers of engineering society activity on the Pacific Coast—namely, Vancouver, Seattle, Spokane, Portland, San Francisco and Los Angeles—some form of an engineering council to coördinate local society activities has been formed or is in process of formation. No two have the same plan of organization—in fact, the point of view is often radically different—but all have the common purpose of broader and more effective service to the profession.

The Vancouver plan is to use the executive committee of the British Columbia Technical Association as a clearing house for matters of general interest to local engineers. This is made possible by making the committee large and having each technical society represented on it by one or more members. Membership in the association is open to technical men of all classes, and does, in fact, include a very large majority of all engineers in the vicinity.

Seattle has long had its Associated Engineering Societies which has done what it could to keep the many organizations pulling together. In that city the multiplicity of technical societies has made it hard to get best results in concerted moves. Within the past two years, however, an engineers' club, where technical men of all branches could lunch together, has done much to develop common ground.

Spokane has a remarkably successful plan for getting action on matters of general importance to engineers. It centers in the organization known as the Associated Engineers, and the real secret of its success is that capable, energetic men have taken an active interest in it. As an example of their work, it may be said that when to the newly formed office of county highway engineer was about to be allotted a salary of $200 per month, the association engineers presented such convincing arguments for a higher salary that $5400 per year was finally allotted.

In Portland there are only sections of national societies to be reckoned with, and organization of the proposed joint council should have been easy. It was unfortunately delayed, however, by a split over the question of including representatives of local organizations affiliated with the American Federation of Labor. Individual engineering societies of Portland have shown their mettle of late, as witness the following: Through society committees, the collection of funds throughout the state for promotion of the national Department of Public Works has been organized very thoroughly. The workers do not confine themselves to the profession, but appear before clubs and luncheon gatherings wherever opportunity offers. When a society passes resolutions indorsing a move a live publicity committee gets notices in the daily papers and then sends clippings to the Congressmen representing Oregon. Two Portland societies vigorously waged a campaign against a proposed city bridge contract recently, and on another occasion the demand of union delegates that the label be put on blueprnts was refused most emphatically and with a clear statement of the reasons therefor.

In San Francisco five sections of national societies and one local are represented in a joint council. This organization found so much to do of state-wide, rather than local importance, that it proposed to the societies of the state that a state council be formed. This met with general and hearty approval; delegates have been appointed and the first meeting of the state council will be held soon. This state-wide plan was discussed in *Engineering News-Record* of Aug. 7, 1919, p. 284.

In Los Angeles the coördination of society activity is effectively accomplished through the Joint Committee, on which are represented seven Los Angeles organizations, all of which are sections of national societies.

Engineering Societies' Paramount Problem

No engineer disputes the present need for unity—the vital necessity of a united political front. No thinking man will deny the engineer his right to the benefits to be derived from such unity. No public man would do other than welcome a united profession that could work out, for him, his economic and civic problems. This is the viewpoint of C. M. Lightburn, past president of the Colorado Society of Engineers, and his conclusion is that the modern society's purpose is one of unity and service not merely for the benefit of members of the organization, but for that of the community of which it forms a part—a bringing together again of that which has been rent asunder by specialization, for the solution of the great problem of reconstruction.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

What Will Engineers Pay To Improve Their Status?

Sir—I was very much interested, and somewhat amused, by the letter of R. B. Shepherd, Jr., valuation engineer, Atlantic Coast Line R. R., which appeared in your issue of Oct. 16, and in which that gentleman passed a few remarks upon the weighty subject of "What Will Engineers Pay To Improve Their Status?" I was interested because I had supposed that the attitude of mind exemplified by Mr. Shepherd was rapidly becoming extinct, and I was amused by the puerility of his remarks.

Mr. Shepherd says:

> Personally, I feel that the engineering societies should confine their *conscious* [sic] efforts to the advancement of engineering knowledge and good practice and to the establishment and maintenance of a high moral and ethical status for the engineering profession. The improvement in status to which your editorial is addressed should result from the spontaneous and voluntary recognition of the beneficial activities of the engineers and of work well done.

Viewed as a detached ethical statement, this is fine; but as a practical proposition it is rank nonsense. I am not in the habit of indulging in games of chance, but I am willing to bet a hundred dollars to a lead

nickel that the extent of Mr. Shepherd's recognition of "work well done," so far as his subordinates are concerned, has been confined to praise, which costs nothing, and that any effort on their part to bring back to parity the fifty-cent dollars with which they are paid would be looked upon by him with horror, as savoring of "labor-union methods." I say this because I know the breed.

It is all very well for engineers, who, during their years of youth and upward struggling, lived in an age when a dollar was worth one hundred cents, to point to the time when they sold their valuable services for two, three and four dollars a day, but they show decided lack of vision, and a most regrettable narrowness of mind, when they fail to coördinate that fact with the present-day conditions of high prices and high wages for all forms of manual labor. They show a further lack of grasp of fundamental principles when they assume that the public, which really knows very little of the functions of the engineer, and his relation to society, will show any respect, let alone accord any recognition, to a profession, the members of which have not enough sense to earn for themselves as high a wage as the unlettered artisan.

If Mr. Shepherd, and others of his kind, expect to advance the status of engineers by confining their activities to the discharge of their duties, and the reading of abstruse and learned papers within the cloisters of their professional societies, they are further showing an ignorance of facts, because the national engineering societies have never, to this day, secured anything like adequate recognition of the value of the services of the engineering profession to the public.

The majority of engineers, of high and low status, are unalterably opposed to affiliation with labor unions, or the employment of labor-union methods in obtaining for themselves adequate compensation for their services. Unfortunately, however, they must live if the engineering profession is to continue to exist, for the youth of the land will not continue to fill the engineering colleges if the career that is thus opened to them does not promise a wage—in its earlier years, at least—exceeding that of the unskilled laborer, and a promise that, if they attain at least a moderate proficiency, they will earn a compensation large enough to enable them to live among their fellow men upon a plane equal to that of others who are doing work requiring similar intellectual capacity. That is the condition which confronts us today, and that is the reason why many engineers in the lower ranks of the profession have become desperate enough to ally themselves with labor-union organizations, and to use labor-union methods to put their pay upon a basis at least comparable with that of the skilled mechanic.

The national engineering societies have at last awakened to the fact that the public is not going to give the engineer his just due unless he goes after it, and Engineering Council is an evidence of that awakening. Engineering Council, however, is not a democratic body, and does not and cannot, as now constituted, represent the vast majority of engineers. The national societies were instituted primarily for professional and technical work. Their standards of membership, admirable for such work, do not represent the rank and file of the profession, and it is the rank and file which constitutes the majority of the profession. Furthermore, it is from the rank and file that the future leaders must come. If there were today no choice between the aid of Engineering Council and that of organized labor, it is probable that a majority of engineers would swallow their pride and affiliate with the latter, for organized labor certainly does get results, however we may disapprove of the methods used.

Fortunately for the welfare of the majority of engineers, and for the future glory of the profession, there exists an organization which is not affiliated with organized labor, and which does not countenance the use of labor-union methods, yet is obtaining results in the recognition and adequate compensation of engineers. This organization now numbers nearly 10,000 members, representing all branches of engineering, and all grades of professional standing, from chief engineers to rodmen. No organization of engineers has ever shown so rapid a growth, or such satisfactory results of accomplishment within so short a period. No organization exists which possesses such means and ability to place the engineering profession upon the high plane to which it is entitled. The American Association of Engineers is unique in these respects, and if its present rate of growth is any indication of its future, we may soon expect even such standpatters as Mr. Shepherd to be asking for admission to its precincts and to its activities, as men of equal standing, and broader understanding, have done before now.

KENNETH P. ARMSTRONG,
Senior Civil Engineer, Interstate Commerce Commission, Bureau of Valuation.
Washington, D. C.

Water-Ratio as Affected by Rodding

Sir—Prof. F. E. Giesecke's tests on rodded concrete, reported in *Engineering News-Record* of Sept. 11, 1919, p. 528, are of interest in showing the increased strength due to this treatment, and in illustrating the extent to which fresh concrete may be disturbed without adversely affecting its strength. The author properly attributes the increase in strength to the removal of the excess water by rodding.

The writer believes, however, that Professor Giesecke is not on safe ground when he compares his tests directly with certain results obtained in this laboratory, and depends on that comparison for a measure of the effect of rodding when using concrete of different consistencies. It is unfortunate that he did not make a parallel group of tests from which the water ratio-strength relation could have been platted for the unrodded concrete. (The water-ratio is the ratio of the volume of water in the batch to the volume of cement, considering cement to weigh 94 lb. per cubic foot.) The strength of his concrete was probably different from ours, due to many factors which had no relation whatever to the effect of rodding. In other words, in his Fig. 2 the water ratio-strength curve for unrodded concrete may have been entirely different from the curve shown (which is based on certain of our tests), due to differences in the quality of the cement, differences in temperature, curing conditions, time of mixing, or numerous other variations which affected all tests alike. The comparison of his earlier tests with our curve is not very convincing.

In our discussions of the water ratio-strength relation for concrete we have pointed out that the constants in the formula quoted by Professor Giesecke ($14{,}000/7x$

(where x is the water-ratio, an exponent) depend on the quality of the cement, age of concrete and other conditions of the test. Other tests made in this laboratory give different values of these constants, although the general relation between water-ratio and strength has been found to hold true for different proportions of given materials, so long as the concrete has water enough to make it plastic and the aggregate is not too coarse for the quantity of cement used.

Professor Giesecke has fallen into an error in plotting his tests in Fig. 2, since no allowance was made for the reduction in the water-ratio of the concrete as a result of rodding, due to one or more of the following factors:

(1) Working water to the surface which escaped and consequently did not influence the final water-ratio.

(2) Evaporation due to long exposure of the cylinder during rodding.

(3) Absorption of water by the aggregate during rodding. Concrete which was originally mixed with a water-ratio of 1.00 may after rodding have a water-ratio of 0.7, consequently the strength should be plotted with reference to the latter figure and not the former. In other words, the curves from Professor Giesecke's tests should all be moved to the left, the exact position being unknown on account of the uncertain effect of rodding on the final water-ratio. If this were done we should find a very different relation from that given by the original figure, and at the same time attribute the increase in strength to the proper cause—that is, the artificial reduction in the water-ratio.

The time of setting of the cement used in Professor Giesecke's tests would have been of interest. Undoubtedly, the plastic condition was quite different for the concrete which had been rodded for long periods from the condition at the beginning. This should be borne in mind in considering applications of this method. It seems probable that the strength would have been quite similar had the concrete been permitted to stand for the periods shown, before being placed in the forms, provided that sufficient water were used in the beginning to provide a plastic mix after the absorption and evaporation had occurred.

In a series of tests carried out by the writer several months ago a study was made of the effect on the strength of the concrete of using different methods of molding the specimen. We were interested only in methods which could be used in molding test cylinders in the laboratory. Compression tests were made on 6x12-in. cylinders at the age of 28 days, using sand and pebbles graded up to 1½ in. A 1:5 normal-consistency mix was used with a water-ratio of 0.87. For 12 strokes of the ⅝-in. steel bar on each 4-in. layer of concrete we secured a strength of 2680 lb. per square inch; for 25 strokes 2780, and for 50 strokes 2810, an increase of about 4% for 25 strokes as compared with 12, and an increase of about 5% for 50 strokes as compared with 12. The first and third values were the average of five tests; the second the average of 15 tests made on different days. Puddling was done during the molding of the specimen and the concrete was not subsequently disturbed. These tests showed a comparatively slight effect due to the different number of strokes used on each layer. Twenty-five strokes for each 4-in. layer is the number regularly used in making our test pieces. It will be noted that the water-ratio of this concrete was not changed, consequently we would expect little effect due to the number of strokes, so long as the minimum number of strokes gave compact concrete. Several methods of tamping were also used. The same series covered a study of the effect of vibration, jigging and pressure.

These tests brought out clearly that the increase in strength due to pressure on fresh concrete may be measured by the quantity of water which is forced out by the pressure. In other words, *it is the reduction in the water-ratio of the concrete which increases the strength.* Complete data will be found in a forthcoming bulletin of this laboratory reprinted from a paper read before the American Concrete Institute, June, 1919, and published also in the "Proceedings" of the institute for 1919.

It is the writer's belief that much of the effect due to workmanship in handling and placing concrete can be traced to the influence of any particular practice on the final water-ratio of the mixture.

D. A. ABRAMS,
Professor in Charge, Structural Materials Research Laboratory, Lewis Institute,
Chicago, Ill.

Experience With Bolted Steel Structures

Sir—I have read with a great deal of interest the article in *Engineering News-Record* of Aug. 14, 1919, entitled "Bolts in Field Connections and Steel-Frame Buildings: a Study of Data and Experience," by R. Fleming, with which my experience leads me to agree in practically all particulars. I was particularly interested in the observations headed "Recommended Clause for Field Bolting," and concerning the use of washers and nut locks.

During the past ten years I have designed and erected several thousand tons of steel structures in the Argentine Republic, principally office buildings in the City of Buenos Aires, and it is in connection with the erection of this work that I comment below regarding the use of ordinary bolts in place of field rivets.

In the case of a building erected in Buenos Aires several years ago the architect specified that field connections, with the exception of ordinary floor-beam framing, should be riveted. The building has about 20 m. frontage, and for a depth of about 25 m. is thirteen stories high. For a further depth of 20 m. it has nine stories. The 13-story portion of the building is about 210 ft. in height above the street, and at one corner has a circular tower 40 ft. higher, making a total of about 250 feet.

In the design of the building, wind stresses were taken care of in the usual manner. The erection proceeded rapidly, for this country, but it was found almost impossible at that time to obtain good field riveting. I was so impressed by the poor results obtained that I suggested to the architect and engineer representing the owners that we would obtain much better results if the building should be properly bolted; and finally that plan was adopted, using ordinary structural bolts, with the exception of the framing below the tower and the elevator shafts in the high portion of the building. The nine-story portion had all field connections bolted.

Owing to a delay in letting the general contract and the fact that the steelwork was erected much more

rapidly than was anticipated, the entire steel frame was completed before any mason work was begun and when only a portion of the concrete floor arches had been constructed. The usual system of plumbing the structure by means of wire ropes had been followed and a final adjustment made, which by careful measurement indicated that in no place was the building more than ¾ in. out of plumb. Just as the work had been completed a violent wind storm, called in this country a "pampero," struck the city, the wind attaining a velocity as high as 110 km. an hour, which carried away practically everything loose on the building, among other things 2 x 12-in. planks 10 to 12 ft. long. As soon as the storm passed investigation was made, and the structure was found to be out of plumb about 4 in. This was easily corrected, and no other similar test occurred before the completion of the walls.

Under the somewhat severe test mentioned, no evidence could be discovered of weakness at any bolted connection, but it was found that a good many field rivets showed signs of looseness, and these were removed and replaced with bolts.

Several years ago I had occasion to erect a four-legged shot tower 210 ft. high, and because it was necessary to save both time and expense, field bolting was resorted to instead of field riveting. The base of the tower is 33 ft. square, with the first forty feet above the ground sharply battered to about 20 ft. square, and from that point to 12 ft. square at the top, at which is located a small house for the operating workmen. In this instance the bolts were locked by cutting the screw threads with a chisel, and although the tower is in an exposed position and has been tested by many high winds no weakness has been noted.

The other buildings and structures referred to earlier, while not as high and perhaps not as severely tested as the two specifically mentioned, were field-bolted in all instances and have proved entirely satisfactory.

While I do not advocate the promiscuous use of ordinary bolts in place of field riveting, it appears clear that well bolted connections are better than poorly riveted ones and for the conditions that had to be met with in the Argentine, at least a few years ago, and where there was little vibration, field-bolted connections have given entire satisfaction.

HUGH B. TABOR,
Representante General, United States Steel Products Company.
Buenos Aires, Argentine Republic.

Sir—We are much interested in the subject of the articles on the use of bolts on structural steelwork, in your issues of Aug. 14, 1919, p. 298, and Sept. 11, p. 529, as we have felt for a long time that many classes of steel structures were made needlessly expensive by the use of rivets where bolts would have served the purpose just as well at much less cost. Some years ago someone defined engineering as the "art of obtaining the most from a dollar." If this definition is true, there has been a great deal of poor engineering done in regard to the use of bolts and rivets, because there are countless places in the structures of this country where a bolt would have given just as good results as a rivet.

We believe, as you say in your editorial of Aug. 14, that "precedent, instead of experience, plays a large part in this particular item of engineering practice." We also agree with you that "experience" in regard to the subject "will be developed by the piecing together of a multitude of small scattered items of observation, very few of which can come under one man's eye." Therefore, we are glad to aid as much as possible in constructing what might be called the "experience structure" of the art by contributing our little item of experience.

That we have been alive to the possibilities in the use of bolts is shown by the specifications which we have been using for some time covering the use of bolts and rivets on certain classes of our work, where we are the engineers. We attach a copy of these specifications, and while you will note that they allow a much more extensive use of bolts than is the usual practice, they are not as radical in this respect as they would have been had they not been drawn to meet the current idea of good practice.

In our experience we have had occasion to use bolts in all kinds of structures. In many of them the complete structure has been bolted and, so far as we know, there has been no loosening of the bolts or failure of the connections in any of them. When we first started to build highway bridges we thought it necessary to rivet all but the simplest connections. Later we found on examination that bolts were perfectly satisfactory, as the nuts had no tendency to loosen. Before we discontinued highway bridge work we had built a great many bridges where the field connections were all bolted.

The coal tipples, shaker houses and other structures of this class that we have field-bolted have all given first-class results. About eight years ago we built and erected a pipe shop having an overhead crane which had to clear some high furnaces, making it necessary to make the building higher than the ordinary structure of this kind. The walls were simply curtain walls and the windows were made with steel sash, so that there were no masses of brick or masonry of any kind to absorb vibration. All of the connections in this building were bolted, and the results have been as good as could possibly have been obtained with rivets.

The writer has been watching for a great many years one job in particular at our own plant on which all the connections are bolted. It is a runway for an outside crane, 10-ton capacity, 80-ft. span. The track is supported by latticed girders. The columns have a wide base, rear flange angles battered, and are laced with angle lacing coped so as to connect in between the web legs of the flange angles. The vibration on this structure has been heavy enough to crack some of the coped ends of these lacing angles, but the writer has never been able to find a loose nut or even a crack in the paint around the nut.

In addition to the work which he did in repairing the bridge for the Chicago & Western Michigan R. R., described in the *Journal of the Western Society of Engineers*, December, 1913, by our Mr. Curtis, and mentioned in Mr. Fleming's article, we have repaired and removed a great many bridges and other structures in the past 25 or 30 years in which the field connections were made with bolts. We took down some bridges for a Southern railroad that had been overloaded for some time; it finally became necessary to replace them by heavier bridges. The field connections were all made with bolts, and when the bridges were taken down we

found the bolts in all of the connections so tight that it was necessary to knock the heads off before they could be removed.

A building which came under the observation of one of our engineers a few years ago was an excellent illustration of the efficiency of bolts for work of this character. It was a cement mill that had been in operation so long that the roof and its supporting steel had become so loaded with cement that the trusses finally collapsed. The points of failure were all found to have occurred either in the body of the member or in the first bolt hole at the connection.

We could give a great many more illustrations in regard to the efficiency of bolts, but it seems that those cited should help to convince anyone that the use of bolts in steel structures could be greatly extended.

E. D. CODDINGTON,
Vice President, Wisconsin Bridge and Iron Company.
North Milwaukee, Wis.

SPECIFICATIONS FOR FIELD BOLTING AND RIVETING ON STRUCTURAL WORK (WISCONSIN BRIDGE AND IRON WORKS)

It is our purpose to do as much field bolting as possible on all structures except railroad bridges. When the customer desires it, or conditions are such as make it desirable to do riveting on a structure, the riveting must be confined if possible to main members as defined below, and the values to be used for bolts and rivets in all cases, unless specifically changed by the specifications covering the contract, will be in accordance with the table shown.

The specifications, strain sheet or information will in all cases state whether riveting will be required on any particular job. The values in pounds per square inch to be allowed for shop and field rivets and bolts are as follows:

	Shearing	Bearing
Shop rivets	12,000	25,000
Power-driven field rivets	12,000	25,000
Hand-driven field rivets	10,000	20,000
Ordinary bolts	10,000	20,000

Stresses will be shown on strain sheets for all main members and their connections shall be fully bolted up or riveted for carrying these stresses. In coal tipples, head frames, rock houses and similar work, members that get stresses from cable pull, dumping skip, machinery vibration, etc., will be classed as main members. In building work, columns, chords of trusses and all members carrying live load will be classed as main members. If any portion of the stress in main members is due to live load suddenly applied, as in trolley beams, crane girders, dumping girders, etc., 50% of that stress will be added to provide for impact.

In case of members where the stresses are indeterminate, and minor members where the stresses are unimportant, the connections shall be bolted or riveted in accordance with our usual practice; that is, the connection shall be proportioned to the size of the member.

Another Chart for Railway Resurvey

Sir—On p. 506 of your Sept. 11 issue is a curve chart, by J. G. Wetherell, for railway resurvey. It is very good as far as it goes, and no doubt the external-distance method is not applicable for much larger central angles than 9°, in the locality for which Mr. Wetherell constructed the diagram. This method does not disclose whether the curve is simple or compound, or yield any data relative to transition curves.

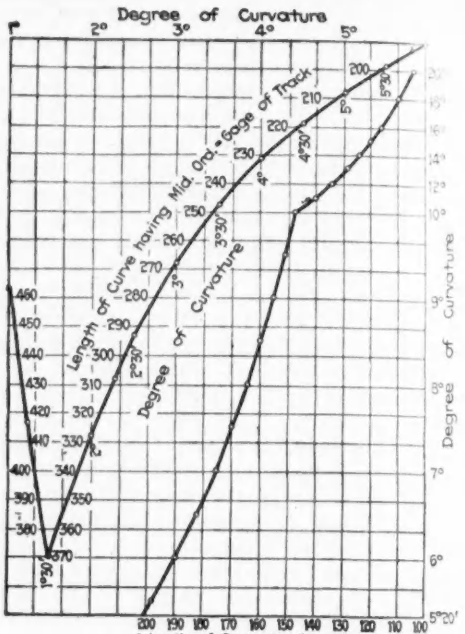

Degree of Curvature
2°
3°
4°
5°
Length of Curve having Mid. Ord. = Gage of Track
Degree of Curvature
Length of Curve having Mid. Ord. = Standard Gage of Track - 4' 8½"

CHART USED FOR RESURVEY OF CURVES

When the writer was engaged on railroad bridge renewal surveys in 1901-04, he often used a simple method of determining approximately the degree of curve without a transit survey. If no change of alignment were contemplated in connection with the construction of a permanent bridge, replacing a timber-trestle or Howe-truss bridge, usually there was no occasion to take a transit to the structure until needed for construction layout.

The method used was to measure the length of curve having a mid-ordinate equal to the gage of track, 4 ft. 8½ in. A point was selected on the gage line of the outer rail, and an assistant lined in on the same gage line at such a point that the connecting line of sight was tangent to the gage line of the inner rail. The length of curve included was chained and recorded. By measuring several such chords overlapping each other, the regularity of the curve was tested.

The determination of the corresponding degree of curvature is simple by the use of a table of "Functions of a 1°" curve and still simpler by such a diagram as the one inclosed. This method is not precise, as the lining in it is done by eye, and a chord of the outer rail instead of the center line of track is used; also, the gage may be widened on the curve. But, even without correcting for these inaccuracies, the results are close enough for some purposes. Where one or both ends of the curve come within the limits of the survey, tangent offsets should be taken for several stations, if convenient. On old track, where centers have not been rerun for several years, irregularities in curvature are sure to be found, as is best realized by those who have had experience in spiraling railroads originally built without spirals.

H. P. BOARDMAN,
Professor of Civil Engineering, University of Nevada.
Reno, Nev.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Turnbuckle Adjustment for Hammer Clutch

By E. Earl Glass
Los Angeles, Calif.

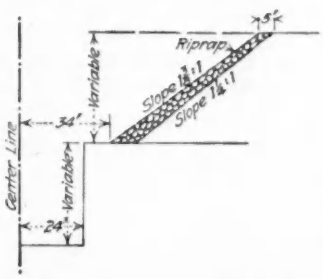
GOOD work with a light shop hammer depends very much upon perfect control. The action of a small power hammer in the shop of the Los Angeles County road department was greatly improved by cutting and threading the rod connecting the tread and clutch and inserting a turnbuckle. By a slight aljustment of the turnbuckle the clutch may be kept sensitive to a touch for light, painstaking work or set up for hard hammering on heavy work. The improvement is well worth the slight trouble of fitting the turnbuckle.

Wood Cribs Hold Toe of Riprap on Slopes

MOST of the rock section of the new power canal around Niagara Falls which is being built for the Queenston-Chippawa Canal of the Ontario Hydro-electric Power Commission is a rectangular cut 48 ft. wide and varying in depth to 60 ft. This cut, however, is in the ledge rock which itself lies a number of feet below the ground surface, and the upper part through the earth has a side slope of 1¼:1 paved with a heavy riprap to a slope of 1⅜:1. As shown in the accompanying cross-section, the edge of this riprap slope is brought to within about 10 ft. of the inner edge of the rock face.

The general scheme of procedure followed is to excavate the overburden to its proper slope with steam shovels, dump the riprap fill over the side in order to hold the earth at its proper slope, and then to start the channeling and drilling operations in the rock thus exposed.

In one section, shown in the accompanying view, the earth tends to slide and the riprap could not be held



CANAL SECTION WHERE CRIB IS USED

to the slope, but tailed over into the rock-cut area. To prevent this, a series of wood cribs, as shown in the view, was built and anchored by through bolts to the rock. These cribs, which are about 6 ft. wide and 12 ft. long, are made of a floor of 10 x 10-in. sticks laid solid between longitudinal 12 x 12's on the outer faces and tied together with three 6 x 6-in. sticks as shown. The frames are placed close together and serve admirably to hold the toe of the rock slope.

Land Drill on Barge Drills Test Hole in Tidewater

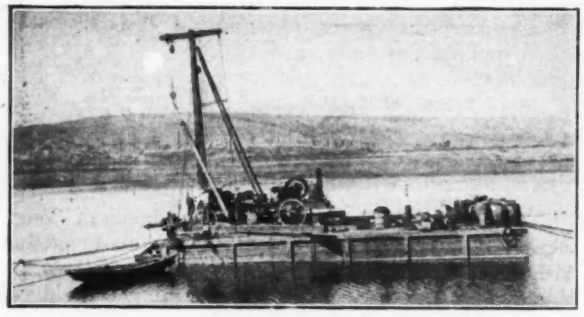
By Adelbert J. Newman
Los Angeles Shipbuilding and Dry Dock Company, Los Angeles, Calif.

SUCCESSFUL test-hole drilling in deep water having considerable fluctuations of tide level was accomplished from a barge, with improvised fittings, in constructing the foundations for the new 10,000-ton dry dock of the Los Angeles Shipbuilding & Dry Dock Co. After one test hole on land, using a portable California well driller, was drilled, the rig was transported to fitting-out wharf No. 2 and placed on a barge by one of the company's steam cranes. The barge was 25 x 50 ft., and was capable of supporting 65 tons evenly distributed and retain a freeboard of 2 ft. Two 10 x 10-in. timbers 30 ft. long were placed under the barge at one end and two 12 x 12-in. timbers 30 ft. long were placed directly over the 10 x 10-in. timbers in a V-shape on the deck. These timbers were bolted together with 1¼-in. steel rods at each end with ½-in. plates and jamb nuts. On the end of the V two 4-in. hydraulic jacks were strapped with ⅝ x 4-in. iron bands. A counterweight of twenty 42-gal. oil barrels filled with sea water, 4 tons, was placed on the rear end of the barge, and the drill was lashed to the decking and guyed four ways. The barge with equipment was towed by a launch to location

TIMBER CRIBS ARE PLACED AT FOOT OF HEAVY RIPRAP SLOPE

of the test hole in the channel and was fastened by eight mooring lines, which were equipped with a set each of double blocks to enable tightening by hand to be done. An armor casing of 10-in. water pipe 37 ft. long was suspended from the barge by large pipe clamps fastened to the 10 x 10-in. timbers, and used to protect the well casing from bending.

The elevation at the beginning of the bore was —31.2 ft., and the hole was drilled to an elevation of —98.0 ft., making an actual drilling length of 66.8 ft. As



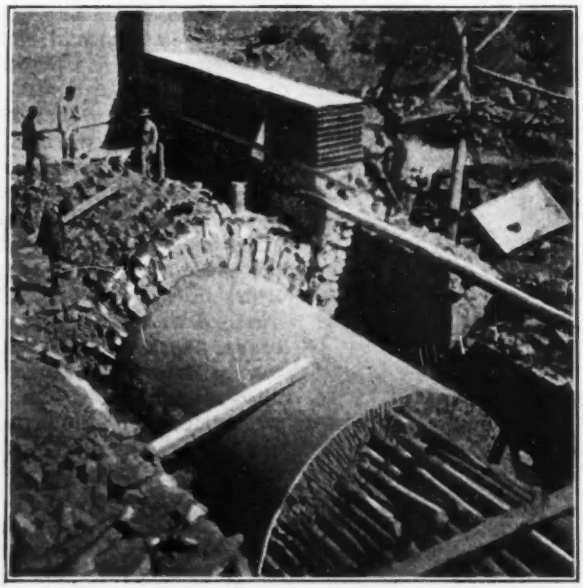
WELL DRILL ON BARGE DRILLS SUBMARINE TEST HOLE

the drilling was done through an average depth of 36 ft. of water, a total length of 102.8 ft. of 8-in. double-ply well casing was required. Working on a barge and taking the necessary precautions made the progress very slow, but no difficulty was encountered that was caused by the tide or motion of the rig. After completing the drilling, the casing was pulled by hydraulic jacks, using 1000 lb. pressure per square inch.

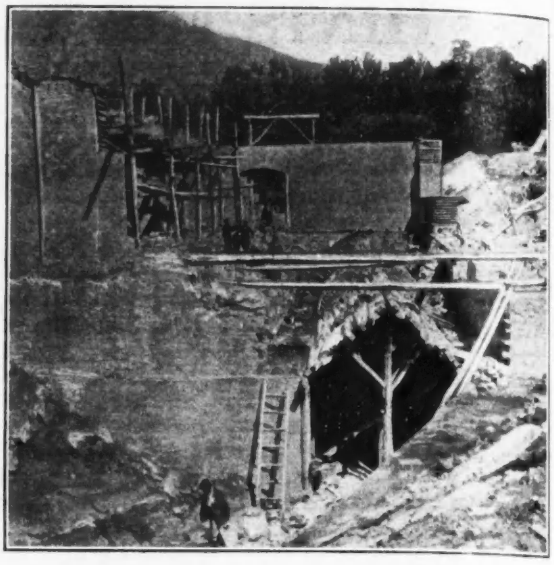
Clampitt & Moss, Los Angeles, Calif., were the contractors, and the drilling was done by W. A. Borden, Artesia, Calif., with his own rig.

Building Arch With Primitive Centers

IN THE construction of a hydro-electric power house north of Kabul, Afghanistan, A. C. Jewett, a California engineer, was forced, by the lack of any timber



ARCH FORMS MADE OF MUD ON BRICKS ON POLES



CENTER POSTS WITH BRACKETS CARRY CENTERING

of fair size or strength, to devise a number of special methods. In forming the arch over the wheel pits, for instance, he could not get timber to make the arch centers, and had to adopt the scheme shown in the accompanying two views. A supporting framework of poles set up in rough branching-arm shape carried a triangular rooflike centering. This centering was then covered with a built-up solid mass of longitudinally laid poles, which was in turn covered with sun-dried thin, flat bricks. These bricks were plastered with mud to form the curve of the arch on which the cut-stone arch voussoirs were laid.

Old Boiler Flues for Coffer Plates

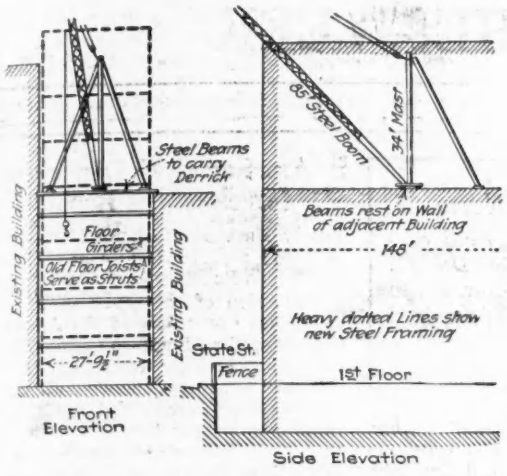
By G. W. McAlpin
Point Pleasant, W. Va.

OLD boiler flues, flattened out with the automatic hammer in the blacksmith shop, cut to desired length and drilled, recently formed a cheap substitute for plates for plating the ends of cofferdam waling on the work of the National Contract Company at Dam No. 25, Ohio River. Plates are usually used to prevent the tie-rods from pulling out through the ends of the waling.

The flattened boiler flues, cut to 15-in. length, drilled for one rod hole and several smaller holes for spiking to waling with boat spikes, have proved entirely satisfactory and have been cheaply made from old flues of no use for original use.

Erection Derrick Straddles Site of Narrow Building

RESTRICTED working space for the erection of the seven-story steel-frame Waterman Building, State St., Chicago, necessitated an unusual arrangement for the support of the stiff-leg derrick which handled and placed the material. The building is only 27 ft. 9½ in. wide, and had to be erected between two other structures. It is 148 ft. deep, with a crowded street in front and a narrow alley at the rear. When the old building was torn down, several of the old wooden floor joists



DERRICK IS SUPPORTED OVER BUILDING SITE

were left in place as struts to support the walls of the adjacent buildings; one of these walls was a party wall. The erection derrick was mounted directly over the site, being supported on steel beams spanning the narrow space and carried by the walls of the adjacent buildings at about the fifth floor lever. It was mounted in such position that it could pick up material delivered in the street, and either place it in the sidewalk basement for storage or set it directly in place in the structure. This derrick had a 34-ft. mast and an 85-ft. steel boom, with a hoisting capacity of 15 tons. Holabird & Roche were the architects; the Dahl-Stedman Co. was the general contractor and Nils J. Johnsen & Co. had the contract for erection of the steel frame.

Reinforced-Concrete Boards Straightened

A NUMBER of precast reinforced-concrete boards forming the compartments of the sludge-drying beds of the new sewage-works of Austin, Tex., were straightened after having been bent by an earthslide. The boards are 2x18 in., 15 ft. long, reinforced longitudinally by six ⅜-in. twisted bars. They were cast flat on a solidly built floor, 10 at one time.

REINFORCED-CONCRETE BOARD BENT BY LANDSLIDE

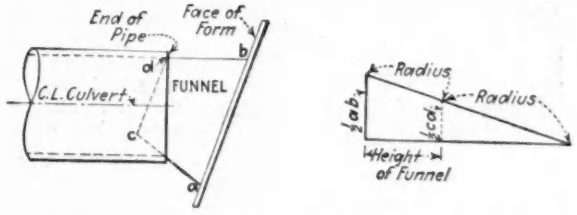
The tops of the boards, as cast, were trowelled. Earth pressure from a landslide bent a number of the boards, some of them being 8 in. out of line. The bent boards were removed, laid flat on the ground and weighted slightly. For the most part they straightened by their own weight. Some still show a slight curve. Not one board failed. Light cross cracks exist at intervals of about 3 in., distributed in the inner three-fourths of the length of the board.

The contractors for the sewage-works were R. J. Potts, C. E. Moore and W. H. Prentice, Waco, Tex., with T. J. Palm as superintendent of construction. C. E. Leonard is city engineer of Austin. Prof. John H. Gregory, Baltimore, Md., designed the works and is serving the city as consulting engineer.

Universal Form for Skew Culvert Ends

By Samuel P. Baird
Engineer and Contractor, Columbus, Ohio

CULVERTS must of necessity be laid with a grade, and often on a skew with the road. The head walls should always be built plumb and parallel with the center line. It is apparent that the formwork for a concrete head wall for a pipe culvert will necessitate some extra work cobbling up a closure for the gap



END FORM ADJUSTABLE TO SKEW OF CULVERT

between the end of the pipe and the form. When the grade of the culvert is slight and the culvert is square with the center line, this gap can usually be filled with stiff clay. But if the culvert has a good grade or is on any skew, it requires patience and skill to make a form that will be concrete-tight and produce a good-looking job when finished.

The writer has successfully used galvanized-iron funnels of various diameters, 8, 10, 12 and 14 in. at the small end, and 18, 20, 22 and 24 in. at the large end, by 15 in. high. These funnels were made in four parts and bolted together with short stove bolts, the nuts being on the outside and the bolts being of such length as to give not quite a full nut. In use, a cone of suitable size is inserted in the end pipe of a culvert, and the base of the cone is adjusted so as to fit squarely the form for the face of the head wall. The cone acts as the ball and the pipe as the socket as in a ball-and-socket joint.

No trouble is experienced in taking care of a skew of 20°. The funnels cannot be made of heavy-gage material, as an oblique section of a cone is not circular, and since we are to joint a cone into a circular pipe on a skew there is some distortion. No. 20- to 24-gage material has been found satisfactory. It is to be understood that the funnels are to be removed as part of the form and re-used.

The rule for cutting a funnel is simple. On a straight line lay off two lines at 90° and a distance apart equal to the proposed vertical height of the funnel. On one of these lines lay off a distance equal to the radius of the large end of the funnel, and on the other line a distance equal to the radius of the small end of the funnel.

Draw a line connecting the two last-mentioned points and extend it to intersect the center line. This intersection point is the center to be used, the radii being the distances to the two points that have been mentioned.

NEWS OF THE WEEK

New York, November 13–20, 1919

Delay Probable in Naming New Chief of Engineers

(Washington Correspondence)

The nomination of the Chief of Engineers was not contained in the early list sent to the Senate by the President. It is understood that the Secretary of War will not make his recommendation until he has had an opportunity to discuss the matter with the President. Secretary Baker regards the present situation with regard to the Chief of Engineers as an unusual one, it is said, and has no intention of hurrying the recommendation.

Considering Revision of Townsend Highway Bill

In a conference with the highway committee of the National Automobile Chamber of Commerce, Senator Townsend admitted that a redraft of his highway bill would be necessary. As revised, the bill will provide a minimum width of 20 ft. for the wearing surface of all highways to be constructed under the act, with the exception of points where physical obstacles make such a width impracticable. In the new bill, the national highway mileage is limited to 1% of the highway mileage of the states, except in cases where such percentage will not allow the two main highways to be extended to the borders of the state. A number of definitions contained in the first bill will be revised. Five commissioners will be provided instead of three, so as to allow better geographical representation on the highways commission. Senator Townsend hopes to begin hearings within the next month or two.

In addition to Senator Townsend and the members of the highway committee of the Automobile Chamber of Commerce, there were present at the meeting H. G. Shirley, of the Federal Highway Council; A. M. Loomis, of the National Grange; A. G. Batcheler and N. O. Eldridge, American Automobile Association, and Pyke Johnson, National Auto Dealers' Association.

Builders Again Press Coal Priority Claims

A committee of the National Federation of Construction Industries appeared before B. P. Phillippe, fuel distributor, United States Railroad Administration, in Washington, Dec. 1, to press their claims for priority rating in the distribution of coal. The committee was composed of representatives of the brick, cement, lumber, lime, sand and gravel and gypsum industries.

In answering the claims of the industries for a higher priority rating, Mr. Phillippe declared that the construction industries now occupied the same status as they did during the war, and suggested they present their claims for a higher rating to Dr. Garfield. Representatives of the industries argued that failure to grant the construction industries a higher rating than they enjoyed during the war would throw a large number of workers out of employment and add to the industrial unrest which is now prevalent throughout the country.

The committee of the National Federation of Construction Industries will hold further meetings with officials of the Railroad Administration, in which they will submit to the coal officials what they believe to be a proper priority rating for the construction industries.

This Week's News

This issue carries news current for the week ending Dec. 10. It is dated Nov. 13—Nov. 20, to preserve the sequence of numbers in the volume.

$284,000,000 for Federal Public Works Planned for 1921

Federal expenditures for public works during the fiscal year which will end June 30, 1921, as such expenditures have been approved by the Secretary of the Treasury and forwarded to Congress, reached the unusual total of $283,921,810.17. This compares with $93,872,092 appropriated for public works during the fiscal year which will end June 30, 1920. The principal engineering items contained in the annual estimates are as follows: Construction of custom houses and other buildings, including the sites and extensions, $1,332,775; marine hospitals, $2,626,000; quarantine stations, $2,776,621; arsenals and powder depots, $7,278,259; fortifications, $117,793,330; military posts, $14,225,251.67; rivers and harbors, $53,659,265; Panama Canal, construction and maintenance, $18,245,391; navy yards and stations, $20,606,000; naval training stations, $2,335,000; depots for coal and other fuel, $2,335,000; marine barracks, $1,019,000; submarine base, San Pedro, Calif., $1,500,000; submarine and destroyer bases, Port Angeles, Wash., and Columbia River, $2,000,000; Reclamation Service, $20,134,000; lighthouses, beacons, and fog signals, $6,759,900.

Am. Soc. C. E. Discusses Development Report

Yearly Dues of $1.50 per Member for Civic and Welfare Work Held To Be Ridiculously Low

Discussion of the report of the Development Committee of the American Society of Civil Engineers, presented at a meeting in New York City, Dec. 3, indicated a strong general sentiment in favor of the recommended expansion of the society's activities to include participation with other engineering organizations in civic and public-welfare work. The committee's recommendations—that the society preserve the integrity of its original purpose to advance the science of engineering; that a reorganization of the society be effected, whereby each of its geographical districts shall be subdivided into local sections, to one of which every society member shall be assigned and whose members shall elect the district representative on the Board of Direction, and that a readjustment and increase of dues be effected—were indorsed by those taking part in the discussion.

The Development Committee's report, introduced by Paul G. Brown, committee member, included the report of the Joint Conference Committee—composed of the development committees of the founder societies—recommending the formation of a comprehensive national association of engineering and allied organizations. This plan was described in *Engineering News-Record* of Oct. 30-Nov. 6, 1919, p. 835.

Mr. Brown's presentation of the committee's recommendations gave the impression that the committee was not very strongly convinced of the value of its own recommendations. Charles Hansel corrected this impression, however, by saying that four of the committeemen, including Mr. Brown, did not favor the inclusion of the conference committee's plan for a single comprehensive organization in the Development Committee's report, but that the vote for the remainder of the report was unanimous. Continuing, Mr. Hansel described the great amount of time and effort which the completion of the report represented.

In reference to the application of $1.50 from the yearly society dues of each member to a fund for the support of the proposed comprehensive national body, Mr. Hansel pointed out that the amount was ridiculously small and should not be less than $5, which opinion was concurred in by several other speakers. Daniel Bontecou, head of the subcommittee on budget, explained that the proposed dues of $1.50 had been considered sufficient to

start the comprehensive organization, as they would produce approximately $60,000 from the four national engineering societies, whose members must necessarily comprise its first membership.

Although F. C. Noble said that the four societies' representation on the National Council of the proposed comprehensive organization would be not more than 11 per cent, E. J. Mehren expressed his belief that it would be more than 60 per cent, and for that reason, he predicted, local associations would not apply for admission. Mr. Mehren criticised the form rather than the substance of the committee's report. With the exception of the conference committee report, he said, it consisted of a mass of indefinite recommendations, arranged in no logical grouping which would allow the reader of the report to gain a clear-cut idea of its object. He had no doubt, he asserted, that most of the recommendations were satisfactory, but that the report should have contained definite plans for their consummation.

Daniel L. Turner, too, urged that action be put on a definite basis and started as soon as possible. The report, however, must first be considered by the Board of Direction. Then definite means for carrying out such of the propositions as gained its approval may be undertaken, involving, of course, a letter ballot to the membership.

The sense of the remainder of the discussion was to urge careful consideration and certain definitions of the proposed changes in the society's organization and affiliations, the encouragement of local sections of the society, and the enrichment of engineering literature by soliciting and publishing more technical papers prepared by local section members.

Sixty Ohio Counties Vote Levies For Better Highways

At the recent state election 60 of 68 Ohio counties voted levies for better roads. Only six counties voted down good-roads projects. The 60 counties voted to spend $6,943,000 on highways during 1920.

Booth & Flinn Get Pittsburgh Tunnel Contract

Contract for building the South Hills tunnel at Pittsburgh for Allegheny County was awarded to Booth & Flinn, of Pittsburgh, as low bidders, following opening of bids Dec. 2. There were five bids, ranging from $4,593,258.50 to $5,658,385.75. The work to be done is the driving and lining of two parallel 25-ft. tunnels 35 ft. apart, 5700 ft. long, through shale rock. A time of 2½ years is allowed for completion. While the bids were far higher than the county commissioners had expected, inquiries made it appear that the cost of labor is not likely to drop for some time, and the contract was then awarded.

Small Salaries Forcing Engineers Out of Government Service

Inadequate compensation is depleting the scientific and technical forces in the Government service at an alarming rate, according to the annual reports of nearly every engineering bureau in Washington.

In explaining why 17% of his scientific force has resigned during the past 12 months, George Otis Smith, director of the United States Geological Survey, reviews the annual record of 29 geologists who have left the Survey to enter private employ. In the Survey, their average salary was $2271. The average initial salary of these men, according to Dr. Smith's calculation, in private employ was $5121. After two years of service this compensation averaged $7804. Eight of these geologists each now receive $10,000 or more.

"That the value of these men as specialists and consulting geologists is far greater to the country at large than to private corporations is undeniable," says Dr. Smith. "With nearly 60% of the area of the country totally unmapped, there is a nationwide demand for more speed in mapping. If these maps are to serve their full purpose in promoting national development, the whole country must be mapped within this generation—or, even better, within the next decade. The estimated cost of this mapping program is $40,000,000, including the cost of revising the older survey. To accomplish this work within the period desired, however, would involve more than the appropriation of this amount of money by the Federal and state Governments. An organization of specially trained engineers must be built up by means of gradually increased appropriations, beginning with $700,000 for the field season of 1919, and reaching a maximum of $4,500,000 in 1928. It is believed that on such a scale of expenditure the field surveys could be both economically and effectively executed, and the work could be completed in 1932."

A. A. E. Announces Attitude on Trade Unionism

After being pressed on many occasions to state its position with reference to its stand on the present situation of industrial unrest, the American Association of Engineers, through its executive committee and past officers, has issued a signed statement under the caption "Statement of the American Association of Engineers on Trade Unionism." The statement follows:

Responsibility—The American Association of Engineers is an incorporated organization responsible for its acts.

Economic Position of the Engineer—The engineer is the medium through which both capital and labor are used in production and in industrial development. The aim of the profession is to advance civilization and render the highest service to society. Except when their acts further this aim, it is an advocate of neither capital nor labor.

Increased Production—Production should be increased—not limited. The profession cannot support strikes or lockouts or any other methods that may benefit any class at the expense of the nation as a whole. They are unsound and must inevitably lead to economic disaster. The law of supply and demand for men or material must ultimately prevail. Attempts may be made to limit the supply of either, but looking toward the upbuilding of civilization we believe rather in increasing the demand through the promotion of legitimate enterprises.

Reward According to Merit—Rewards should be according to ability, initiative and constructive effort. Men are not equal in these respects. Each man should be encouraged to do his utmost and be given compensation according to ability and will to increase production and to achieve large results.

Methods—The engineer, as an educated professional man, believes in basing his claims for proper and just reward for his services upon the justice of the facts presented, upon enlightenment of public opinion, upon loyalty between employer and employee, and upon the underlying fundamental desire of the great majority to do what is fair and right when the merits of the case in question are clearly presented and demonstrated. We believe in organized representation for the correction of wrong, the advancement of the profession and service to the public, but are opposed to methods inconsistent with the dignity of the profession and which would lessen public confidence.

Conclusion—The American Association of Engineers, through its board of directors, who have signed this statement, recognizing the many fundamental differences between the principles and objectives of the trade union and of an organization of professional men, expresses the opinion that an engineer cannot subscribe to the tenets of both.

Program for Highway Transport Conferences Ready

Problems dealing with the operation of motor trucks from the standpoint of efficient service, heavy haulage by farmers, intercity express operation, and a consideration of transportation legislation, are among the subjects to be discussed at the Highway Transport Conferences to be held in connection with the National Motor Truck Show in New York City beginning Jan. 5, 1920. Speakers for the several programs, to be given at afternoon and evening sessions the entire week beginning Jan. 5, 1920, are to be chosen from among those not only interested in the construction and distribution of heavy motor trucks, but also from men engaged in the construction of highways and in the solution of various highway transportation problems.

The program of the Highway Transport Conferences provides for an inaugural session on the opening night, when general subjects of highway and motor transportation will be discussed with special reference to the economics involved. During the remaining six days' conference, sessions will be held in the afternoon, primarily intended for those engaged in the motor-truck business—including manufacturing, distribution and service—and in the evening primarily for motor-truck owners, operators, shippers and any others interested in motor transportation. On the closing day there will be a single joint session in the afternoon. The conferences will be repeated in Chicago in connection with the National Motor Truck Show there, the sessions to begin on Jan. 24, 1920.

One of the features of the confer-

ence sessions will be the liberal use of illustrations, both stereopticon slides and motion-picture films. A collection of films, dealing with motor transportation in all its varied phases, is now being made, several such being obtained from abroad.

Los Angeles Starts To Construct Owens Gorge Power Plants

Camps are being established and construction is under way on the water-power plants to be built in the Owens River Gorge which is part of the Los Angeles water-supply system. This section of the city's holdings is about 300 miles north of Los Angeles. The gorge is the outlet from the higher level part of the Owens River basin, known as Long Valley. The river falls about 2400 ft. in the 12 miles between Long Valley and the lower end of the gorge, and all of this head is to be utilized. Whether three or four plants will be built is to be decided later. By Dec. 15, 1919, 150 men are to be in the camps, and this number will be doubled when all seven camps are established early next year.

The chief item in the construction program is the tunnel work, of which there will be a total of 12 miles. This is to be carried on from eight headings simultaneously.

The diversion dam is to be a rock-fill structure faced with concrete. At the site selected, a dam 100 ft. high will retain 98,000 acre-ft. Owing to the volcanic formation in the reservoir site, however, the height of the dam will not be built up rapidly, but water will be stored as the work progresses, and the dam will be carried up only so far as the reservoir is found to be reasonably tight.

It is part of the plan to get power for construction purposes out of the sections of the permanent construction that can be built at the outset. The first work was a timber crib diversion dam which would have been needed, anyway, to unwater the dam site. With only a short section of temporary flume, the diverted water is conveyed into the permanent concrete flume leading to the first tunnel portal. When the tunnel portal is reached a head of 18 ft. has been developed, and this is used to drive an 80-kw. generator. This has been providing power with which to drive the adjacent 7400-ft. tunnel.

When this first tunnel is completed, a construction power house will be put in to utilize the 50-ft. head between the natural channel of the river and the lower end of the tunnel. A 600-kw. generator here will supply power for all the construction camps. Thus, by carrying out some of the upper construction first the necessary power is being produced with least outlay.

William Mulholland is chief engineer of the Los Angeles Bureau of Water Works and Supply and H. A. Van Norman is superintendent of the northern division.

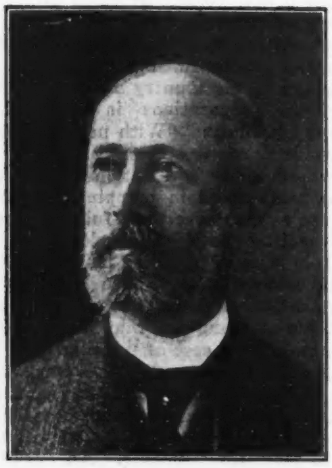
An Appreciation of F. P. Stearns

By Allen Hazen

Consulting Engineer, New York City

For many years Mr. Stearns has been a leader of water-works engineers. More than thirty years ago, as engineer of the Massachusetts State Board of Health, his exhaustive studies of the qualities of the water-supplies of the state, and the means of controlling and improving them, not only established the practice in Massachusetts and other states, but set a new standard for scientific investigations. In a similar way, and at about the same time, his study of stream flow and storage led to establishing the principles of economical development, since used by the engineers of New England. Later, as chief engineer of the Metropolitan Water Board, and afterward in his wide consulting practice, he had occasion to develop and to apply these principles in ever-widening circles.

Past-President, Am. Soc. C. E., and Noted Water-works Engineer, Who Died Last Week



FREDERIC P. STEARNS

Mr. Stearns was one of the men with whom one could discuss differences of opinion on professional matters in the most vigorous way, but with the utmost fairness and without risk to cordial personal relations. No one was more ready than he to recognize the force of new data or of changed conditions; and, on the other hand, no one would stand up more strongly for points that he was supporting.

There can be no better evidence of the fairness of his disposition than is found in the record of the great volume of contract work handled without litigation, and of the innumerable settlements with owners of land and riparian rights and other claimants in the large enterprises that were entrusted to his care.

The writer first met Mr. Stearns more than thirty years ago when he entered a coördinate department of the work of the State Board of Health. He remembers with great pleasure the frequent meetings with Mr. Stearns, and his cordial appreciation of good work and new methods of attacking the difficult problems that were presented.

In recent years, and since the larger activities of the Metropolitan Water Board have passed to other hands, Mr. Stearns has been in the enviable position of being able to select for his professional work problems in which he was particularly interested. He has often expressed to the writer his preference for doing only so much work as he could attend to in his own way and to his own satisfaction and without feeling crowded in doing it. The mark of careful and thorough study that he was able to put on the problems that he did take up may be seen in the many water-works systems with which he had to do, in the construction of the Panama Canal, and, indirectly, through a far wider field by its effect on the engineers with whom he came in contact and who knew him well.

[*An outline of Mr. Stearns' professional career will be found in the obituary column of this issue.*—Editor.]

Proceed With Desgins for $3,000,000 Bridge at Detroit

A bill authorizing the City of Detroit to construct and operate a bridge across the American channel of the Detroit River to Belle Isle was passed by the United States Senate Dec. 2.

Approval of the construction of the new $3,000,000 Belle Isle bridge at Detroit, Mich., without a drawspan, was granted by the United States Engineer Office, and plans were sent to Washington for the final approval of the War Department. At Washington approval was denied, a drawspan being required regardless of the height of the bridge. The Congressional grant for the original bridge across the American channel at this point specified a drawspan. In order to carry out the design of the bridge as planned with a solid span which will close the American channel to vessels larger than pleasure craft and scows, action by Congress at as early date as possible will be asked.

In the meantime the engineers in charge of the bridge construction, Esselstyn, Murphy & Handford, Detroit, are proceeding with the design of approaches to the bridge. A subway under Jefferson Ave. is planned to separate traffic at this point, where the boulevard crosses Jefferson Ave. near the north approach to the bridge. This subway will have a roadway approximately 36 ft. wide and will have a grade of about 3½ per cent.

It is planned to proceed with work on this approach, in view of the fact that when completed this dip will relieve congestion at the approach of the present temporary bridge, while action is being awaited with regard to the main span of the bridge.

Building Trades Employers and Employees Sign Two-Year Wage Agreement

Representatives of the Building Trades Employers' Association and the Building Trades Council in the City of New York have signed an agreement providing for a fixed scale of wages from Jan. 1, 1920, to Dec. 31, 1921, establishing a 44-hour week and providing that at all times unions, parties to the agreement furnish sufficient men to man the work of Building Trades Employers' Association members. The agreement is entered into "in order to secure continuity of employment and uninterrupted production." Approximately 150,000 building trades workers, members of more than 40 unions of 33 classes of mechanics, are affected by the agreement.

Provision is made for the readjustment of the wage schedule during the calendar year 1921, should the cost of living materially change, notice of a desire for readjustment being made by either party five months prior to Jan. 1, 1921. It is also provided that existing trade agreements between association members and unions representing their trades shall be continued under their present terms and conditions until the expiration of the new agreement, unless changed by the mutual consent of the parties concerned. However, the working week and the wage schedule above provided for shall be binding on existing agreements.

Regular or consecutive overtime is allowed only through the consent of a joint committee consisting of the chairman of the Board of Governors of the Building Trades Employers' Association and the chairman of the Building Trades Council. However, occasional overtime made necessary through the exigencies of the work is allowed. The unions either in whole or as a single union are forbidden to strike against any member of the Building Trades Employers' Association, nor are any number of union men allowed to leave the work of a member of the Building Trades Employers' Association. Lockouts on the part of the Building Trades Employers' Association members are also forbidden. In case of the violation of the contract upon the part of union men, employers are allowed to man the work with such men as can be obtained.

A closed shop among building trades employers is indicated in the agreement, which provides "that if workmen not members of the union parties hereto are alleged to be employed on any job whereon any member or members of the Building Trades Employers' Association are doing work, it shall be brought immediately to the attention of the board of arbitration . . . and if the facts are found by said board to be as alleged, it shall not be deemed a violation of this agreement or of any trade agreement for any member of the unions above mentioned to refuse to work on the job in question, unless such workmen are justifiably employed in the case" wherein union men have already violated the contract through strike or through absenting themselves from the job for several days' time.

A permanent board of arbitration is provided for, consisting of five members each of the executive committee of the Board of Governors of the Building Trades Employers' Association and of the executive committee of the Building Trades Council. Disputes arising relative to alleged violations of the agreement or the intent or meaning of any part of it are to be referred to the arbitration board, and if no decision is reached after three days of consecutive meetings the board of arbitration is to select an umpire and his decision in the case shall be final and binding upon all parties.

The following is the wage scale named in the contract:

Class of Work	Dollars Per day, eight hours
Art glass workers	
Asbestos workers and insulators	8.00
Bluestone cutters	8.00
Carpenters	8.00
Dockbuilders, house shorers and sheathpilers	7.50
Cement masons	8.00
Cement and concrete workers (laborers	
Composition roofers and waterproofers	7.00
Composition roofers and waterproofers (foremen)	7.50
Electrical workers	8.00
Electrical workers' helpers	4.50
Elevator constructors	8.00
Elevator constructors' helpers	6.00
Granite cutters	8.00
Hoisting engineers by the week	46.75
Hoisting engineers by the day	9.00
Hoisting engineers running compressors extra per week	7.00
Housesmiths' and Bridgemen's Local No. 40	8.00
Housesmiths' finishers, Local No. 52	8.00
Housesmiths' helpers	6.00
Marble cutters and setters April 1, 1920.	8.00
Marble carvers April 1, 1920.	9.00
Marble polishers, bed rubbers and sawyers April 1, 1920.	7.50
Marble cutters' helpers, riggers, crane and derrickmen	6.00
Mosaic and terrazzo workers	7.00
Mosaic and terrazzo workers' helpers	
Metallic lathers	8.00
Painters and decorators	8.00
Plasterers	8.50
Plasterers' laborers	6.00
Plumbers and gasfitters	8.00
Roofers and sheet-metal workers	8.00
Steam and hot-water fitters	8.00
Steam and hot-water fitters' helpers	6.00
Tilelayers	8.00
Tilelayers' helpers	6.00
Upholsterers	9.25
Wood lathers	8.00

Civil Service Examinations

Canada.—Assistant in wood preservation, Forest Products Laboratory, Montreal, Department of the Interior, $1320 per year. File application with Civil Service Commission of Canada at Ottawa before Dec. 18.

United States

For United States civil service examinations, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Town manager, $2400 per year, Dec. 16. To fill vacancy in Ordnance Department, Nitrate Plant No. 1, Muscle Shoals, Ala. File applications before Dec. 16.

Structural steel inspector, Naval Ordnance Plant, South Charleston, W. Va., $7.04 per diem, Dec. 23. File applications before Dec. 23.

Civil engineer, Philippine service, $2500 to $3000 per year. Applications received until further notice.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

BRIDGE BUILDERS' & STRUCTURAL SOCIETY, 50 Church St., New York City; Jan. 16, New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS, 29 W. 39th St., New York City; Jan. 21-22, New York City.

ENGINEERING INSTITUTE OF CANADA; General Secretary, Fraser S. Keith, 176 Mansfield St., Montreal; Jan. 27-29, Montreal.

AMERICAN ROAD BUILDERS' ASSOCIATION, 150 Nassau St., New York City; Feb. 9-13, Louisville, Ky.

AMERICAN WOOD-PRESERVERS' ASSOCIATION; Secretary-Treasurer, F. J. Angier, Mt. Royal Station, Baltimore; Feb. 10-12, Chicago.

AMERICAN CONCRETE PIPE ASSOCIATION; 210 South La Salle St., Chicago; Feb. 20-21, Chicago.

The Engineers' Club of Philadelphia will hold a regular meeting Dec. 16, at which Capt. Fred Place, director, United States Army School of Aërial Photography, Langley Field, Virginia, will speak on "The Engineering Possibilities of the Airplane and the Progress of Aërial Photography in the Recent War." At a junior meeting held Dec. 9 H. A. Hoffer, of the United States Cast-Iron Pipe & Foundry Co., spoke on "The Manufacture and Uses of Cast-Iron Pipe." At the weekly luncheon Dec. 9, T. E. Mitten, president of the Philadelphia Rapid Transit Co., spoke on "Philadelphia's Transit Problem."

The American Association of Engineers has recently organized chapters or clubs in the following cities: Globe and Phoenix, Ariz.; Terre Haute, Ind.; San Antonio, Tex.; Tulsa and El Reno, Okla.; Joliet, Rock Island, Moline and Springfield, Ill.; Butte, Mont.; Davenport, Iowa; Morgantown, W. Va.; Pocatello, Idaho; Arkansas City, Ark.; Akron, Ohio.; New Orleans, La.; Newell, S. Dak.; and at the Universities of Minnesota, Arizona and Michigan.

The Detroit Engineering Society held a meeting Dec. 5 at which Lieut. Col. Alfred H. White, Nitrate Division, U. S. A., and professor of chemical engineering, University of Michigan, spoke on "The Engineer's Problem in Nitrogen Fixation." At the meeting Nov. 28 Charles Whiting Baker, consulting editor, *Engineering News-Record*, and David A. Molitor spoke on the Jones-Reavis bill providing for a national Department of Public Works.

of Michigan, also commented on the proposed bill. A resolution in favor of the proposed Federal Public Works Department was presented by Gardner S. Williams, seconded by David A. Molitor and unanimously indorsed by a representative attendance of the society and associated organizations. The resolution provides that the Detroit Engineering Society and other interested organizations of Detroit request and urge the representatives of Michigan in Congress to give the bill their earnest and continuing support. A copy of the resolution has been forwarded to each of the Senators and Representatives of Michigan in Congress.

PERSONAL NOTES

COL. HENRY C. JEWETT, formerly chief of staff to Maj. Gen. William H. Johnston, 91st Division, has been placed in charge of the St. Paul United States Engineering District, relieving Maj. George W. Freeman, who was one of the few civilian assistants to be put in charge of a district during the war. When war was declared Colonel Jewett was stationed at Portland, Ore., and afterward organized the 316th Engineers. Major Freeman has been transferred to the Chicago district.

CLAUDE H. BIRDSEYE, who was discharged from military service last June with the rank of lieutenant colonel, has been appointed chief geographer of the United States Geological Survey, succeeding R. B. MARSHALL, resigned, as noted elsewhere. Mr. Birdseye has been connected with the Geological Survey since 1901, and has been in charge of work in Hawaii and the Rocky Mountain division. Early in 1917 he became captain of engineers, and soon afterward was sent to France with the rank of major. He served as topographic officer with the First Army and with the Chief of Artillery of the A. E. F., and was promoted to the rank of lieutenant colonel in 1918.

H. W. HOUGHTON, who recently resigned from the engineering department of the Kansas City Southern R.R., has become associated with the Nebraska State Highway Engineering Department as designer, with headquarters in Lincoln.

LINN BROWN, recently in military service, has been appointed city engineer of Jefferson City, Mo.

B. L. TAYLOR has been appointed county engineer, Woodbury County, Iowa, with headquarters at Sioux City.

H. S. ALLEN, who was recently connected with the Portland Cement Association in Kansas territory, has been appointed resident engineer of Federal-aid road projects in Barton County, Kansas, with headquarters at Great Bend.

W. A. WHEELER has engaged in private practice, with office at 2335 Olive St., Kansas City, Mo.

J. O. HACKENBERG, division engineer, Pennsylvania Lines East, with headquarters at Wilmington, Del., has been appointed principal assistant engineer of the southern division, succeeding J. C. AUTEN, who has received a leave of absence.

F. M. SLOANE has been appointed district engineer, Rocky Mountain, Missoula and Idaho divisions of the Chicago, Milwaukee & St. Paul R.R. west of Mobridge, with headquarters at Butte, Mont., succeeding C. T. JACKSON.

COL. E. B. CUSHING, who has received his discharge from military service, has resumed his position as engineer maintenance of way, Southern Pacific Lines in Texas and Louisiana, under Federal management.

F. LAVIS, consulting engineer, American International Corporation, New York City, has been reappointed special lecturer on railway engineering, Sheffield Scientific School, Yale University, and will resume his course of lectures, which was interrupted during the war.

GEORGE E. RENDIGS, building commissioner of Cincinnati, and his two principal assistants, R. R. PANZER and JAMES A. MARTIN, have resigned to become associated in partnership in the practice of architectural engineering.

J. F. COLEMAN, who has completed the construction of the shipyard at Mobile, Ala., for the Chickasaw Shipbuilding & Car Co., and E. H. COLEMAN, who has received his discharge as captain of Engineers, have resumed private practice with office in the Hibernia Bldg., New Orleans, under the firm name of the J. F. COLEMAN ENGINEERING COMPANY.

S. K. YOUNG, formerly field engineer, Miami Conservancy District, at Dayton, Ohio, has resigned to become chief engineer, Upper Scioto Conservancy District, with headquarters at Kenton, where the work involves the improvement of 20 miles of the channel of the Scioto River through Hardin County.

C. S. BENNETT, who has been with the Miami Conservancy District for the past two years, has been appointed field engineer at Dayton, Ohio, succeeding S. K. YOUNG, resigned, as noted above. Mr. Bennett was previously connected with the Department of Public Roads of Kentucky.

FRANCIS DONALDSON and PAUL M. KUDER have organized the American Contracting Co. with offices in the Commercial Engineers' Bldg., 35 W. 39th St., New York City.

MARCUS M. FARLEY will be in charge of the engineering work of the American Contracting Co., 35 W. 39th St., New York City, which has been formed by FRANCIS DONALDSON and PAUL M. KUDER, as noted above.

J. HENRY MILLER, of J. Henry Miller, Inc., contractors, Baltimore, has been elected president of the Baltimore building code committee, with G. R. MORSE, 533 Title Bldg., Baltimore, as secretary.

AMOR KISTNER, engineer, building commissioner's office, Cincinnati, has resigned to become associated with the Ferro-Concrete Construction Company.

RUSSELL EASTON has been appointed engineer, building commissioner's office, Cincinnati, succeeding AMOR KISTNER, resigned, as noted above.

H. P. HAYES, county engineer, Tarrant County, Texas, has been placed in charge of all maintenance and highway work in the county, in addition to his other duties.

MERRITT DRAIN, road engineer, Jefferson County, Kentucky, has been elected president of the State Highway Road Engineers' Association.

L. L. STONE, chief engineer, Pike Light & Power Co., Pikeville, Ky., has become chief engineer, Peerless-Elkhorn Coal Co., with headquarters at Elkhorn City, Ky.

A. T. SMITH, who recently returned from service overseas, has become engineer of roads, Pike County, Kentucky.

W. F. B. HAYNSWORTH, for the past four years city engineer of Greenville, S. C., has resigned to become assistant commissioner of public works of the City of Winston-Salem, N. C., and will become commissioner on the first of the year.

S. HERBERT GRIFFITH has resigned as road engineer of Talbot County, Maryland.

HOWARD M. TURNER, who has been engaged in private practice since his discharge from the United States Engineers, has opened a consulting office at 70 State St., Boston. Before entering military service Mr. Turner was assistant to the president and hydraulic engineer, Turners Falls, Mass., Power and Electric Company.

H. BURDETT CLEVELAND, who has been connected with the sanitary engineering division of the New York State Department of Health for the past 14 years, has resigned as principal assistant engineer of the department, to become a member of the BARTH ENGINEERING & SANITATION CO., INC., New York City.

JOHN WALTER LEDOUX, consulting engineer, Swarthmore, Penn., has been awarded the Edward Longstreth medal of the Franklin Institute for his invention of the "Simplex" venturi meter.

R. B. MARSHALL has resigned as chief geographer of the United States Geological Survey, to undertake the active management of a ranch in the San Joaquin Valley in California, but

will continue his relationship with the Geological Survey in a consulting capacity. He is succeeded by CLAUDE H. BIRDSEYE, as noted elsewhere.

J. N. LEECH has resigned as city engineer of Steubenville, Ohio, and has been appointed county surveyor.

PAUL BURNS EATON has been appointed instructor of mechanical drawing, Carnegie Institute of Technology.

W. W. JAMES has been appointed assistant valuation engineer, Central Railroad of New Jersey and the New York & Long Branch Railroad.

WILLIAM Z. PRICE has been appointed assistant professor of civil engineering, Carnegie Institute of Technology. Mr. Price was formerly assistant editor of *The Collier*.

R. D. COLEMAN, county engineer, Atchison County, Kansas, has been appointed resident engineer in charge of hard-surface road construction in Atchison County.

FREDERICK D. WOODRUFF, New Jersey State Highway Commission, has been appointed instructor of surveying in a new class organized at the Trenton School of Industrial Art.

D. W. WEBSTER, district state highway engineer, Lyon County, Minnesota, has been appointed divisional engineer, with headquarters at the Minnesota Highway Commission offices in St. Paul.

C. W. ANDERSON has been appointed district state highway engineer, Lyon County, Minnesota, with headquarters at Marshall, succeeding D. W. WEBSTER, appointed divisional engineer, as noted above.

E. Y. ALLEN has been appointed valuation engineer, Philadelphia & Reading R.R., Central Railroad of New Jersey and associated lines under Federal management.

C. R. SEABROOK, structural engineer, H. M. Lane Co., Detroit, has been made chief engineer of the company.

CHARLES T. ABRAHAM, engineer, rate and statistical department, United Gas & Electric Engineering Corporation, Memphis, Tenn., and later associated with J. H. PERKINS, consulting engineer, Birmingham, Ala., is now engaged in the appraisal of the Memphis Street Railway Company.

HENRY L. LIDDELL has been appointed instructor in the civil engineering department of the Massachusetts Institute of Technology.

H. L. LANING has been appointed assistant valuation engineer, Philadelphia & Reading R.R., Atlantic City R.R., and Port Reading Railroad.

WILLIAM W. MCCLENDON and A. B. PURNELL have become associated under the firm name of MCCLENDON & PURNELL, and will engage in private practice at Mineral Wells, Tex., specializing in municipal and highway work. Mr. McClendon will continue his work as city engineer of Mineral Wells.

T. REDMOND BURKE, former district engineer, Lewisburg district, Greenbrier County, West Virginia, has been appointed superintendent and general manager of the Duncan Construction Co., Marlinton, W. Va.

G. B. ROBERTS, PAUL STEENSTRUP, and BEN CROSS have entered private practice in Charleston, W. Va., under the firm name of the ROBERTS ENGINEERING Co., and will specialize in municipal work.

JOHN. B. BABCOCK, formerly instructor in civil engineering, Massachusetts Institute of Technology, has been appointed assistant professor of civil engineering.

OBITUARY

FREDERIC P. STEARNS, consulting engineer, Boston, and past president of the American Society of Civil Engineers, died in Boston Dec. 1. Mr. Stearns had been engaged in engineering work for 47 years, and achieved international recognition as a specialist in water-supply, hydraulics, and dam construction.

He was in charge of a great part of the development of the Metropolitan Water-Supply System of Boston and acted as a consultant in water-supply for many other cities. He was recognized as an authority on the design and construction of large earth dams and foundation work. In the administration of President Roosevelt he was a member of the board of consulting engineers for the Panama Canal, and later accompanied Secretary of War Taft to the isthmus to pass upon the stability of foundations for the proposed locks.

Mr. Stearns was born at Calais, Me., in 1851, and received a common-school education. At 18 he went to Boston and began his career as an engineer by obtaining employment in the office of the city surveyor. Three years later he became a member of the engineering staff of the Boston water-works, first as assistant engineer on preliminary surveys and investigations, and, two years later, as engineer in charge of the construction of a portion of the Sudbury aqueduct. At this time he became associated with Alphonse Fteley in experiments relating to the determination of flow of water, and, in 1882, in collaboration with Mr. Fteley, he wrote the paper, "Description of Some Experiments on the Flow of Water Made During the Construction of Works for the Conveying of Water of the Sudbury River to Boston," which was published in Volume XII of the *Proceedings* of the American Society of Civil Engineers. For this the authors received the Norman medal.

From 1880 to 1886 Mr. Stearns was identified with the construction and maintenance of drainage works in the City of Boston, and had charge of the construction of the outlet tunnel under Dorchester Bay, as well as the reservoir and outfall works at Moon Island. From 1886 to 1895 he was chief engineer of the Massachusetts State Board of Health, and had charge of investigations concerning the disposition of sewage from the Charles River and Mystic River valleys, and a new water-supply for Boston and vicinity. It was during this period that the classic experiments on water and sewage treatment at the Lawrence experiment station were begun — experiments with which the names of Mills, Drown, Sedgwick, Hazen, Fuller and others are also associated.

From 1895 to 1901 he was chief engineer of the Boston Metropolitan Water Board, from 1901 to 1907 of the Metropolitan Water and Sewerage Board, and from 1907 until his death he served as consulting engineer of the latter board. As chief engineer of the Metropolitan Water Board, Mr. Stearns was responsible for the design and construction of the Wachusett dam and reservoir, with its notable earth dike, and the design and construction of the Nashua aqueduct and accessories which now supply Boston and 10 other cities and towns. He was one of the first American engineers to employ landscape design on a large scale in connection with municipal water-supply systems and to secure the collaboration of landscape architects to that end.

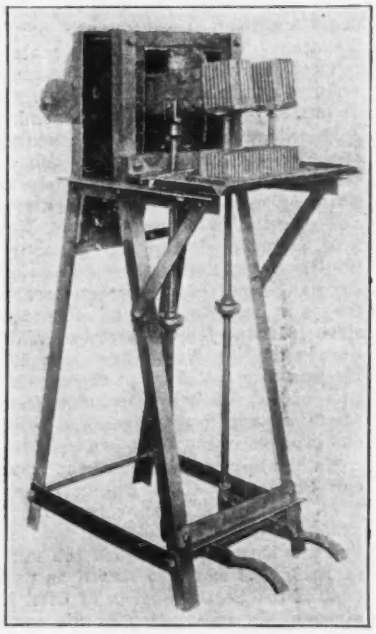
Mr. Stearns' services as a consulting engineer were widely sought. He was retained to advise in water-supply and sewage-disposal matters at Baltimore, Los Angeles, Winnipeg, Seattle, Hartford, Denver, Rochester, Pittsburgh, the District of Columbia, and elsewhere. He had been consulting engineer for the new water-supply of Providence since 1914 and for the Board of Water-Supply of New York City since 1905. He was also called in on the construction of the Chicago Drainage Canal, the Mississippi power dam, and numerous projects in the West and in Mexico.

He had been a member of the American Society of Civil Engineers since 1878. He was a director from 1893 to 1895, vice-president in 1898 and 1899, and was elected president of the society in 1906. He had also served as president of the Boston Society of Civil Engineers. In recognition of his contributions to the advancement of engineering, he received the degree of Master of Arts from Harvard University in 1905 and in 1906 received the degree of Doctor of Science from the University of Pennsylvania. At the Paris Exposition in 1900 he received a gold medal in recognition of his work in water-supply engineering. He was a Fellow of the American Academy of Arts and Sciences and an honorary member of the New England Water Works Association.

MASON R. STRONG, consulting engineer, New York City, died in Passaic, N. J., Dec. 2. Mr. Strong received his education in the School of Architecture and the School of Mines of Columbia University, from which he was graduated in 1889. In 1890 he became connected with the New York, Lake Erie & Western R.R. in masonry and bridge work, and afterward with its successor, the Erie R.R. Three years later he became assistant engineer in charge of structural plans, and in 1895 was appointed assistant engineer for the Erie R.R. on plans of grade-crossing work at Buffalo. In the following year he was in charge of the design and construction of a large amount of bridge work, and in 1900 was in charge of the reconstruction of the Kinzua viaduct and the Chenango Street viaduct at Binghamton, N. Y. Following this work he became bridge engineer of the Erie R.R. He resigned several years ago to enter private practice in New York City.

Heating Rivets Electrically

The General Electric Co. is the designer of an electric rivet heater which has recently been placed on the market. The chief claims for the new device include simplicity of operation, low



ELECTRIC RIVET HEATER

first cost, and maximum efficiency. The general design of the machine is as follows:

A transformer rated at 15 kw. is mounted on angle-iron legs, which may be fitted with wheels. At the front of the transformer, two copper bars are fitted with heavy air-cooled electrode blocks of cast copper, and under these is another copper block which acts as a support and electrical connection for two rivets in series. When the rivets are ended up on the block and the electrodes are allowed to drop on their heads, the circuit is completed and the heating begins. The two electrodes may be raised independently by two foot-pedals. A primary tap switch mounted on the back legs of the machine gives all the variation needed for different lengths and diameters of rivets and the rate of heating desired.

Heaters of the sizes so far developed are a 5-kw., two-jaw heater for rivets up to ¾ in., and a 15-kw., two-jaw machine for rivets up to ⅞ in. in diameter. The two-jaw heaters are intended for one-gang use; however, in actual test the 15-kw. machine heated five hundred ¾-in. by 1¼-in. rivets in one hour, which is ordinarily enough for two gangs of gun riveters. A number of obvious advantages present themselves in the use of the electric heater.

Asphalt Association Establishes Office in Washington

Washington has been chosen as a district headquarters by the Asphalt Association, whose main office is in New York City. The office will be in charge of Maj. Harry D. Williar, who served overseas with the First Division. Before entering the service Major Williar was an engineer on the Maryland State Road Commission and later with the Baltimore Paving Commission. Included in the Washington district are the States of Maryland, Pennsylvania, Delaware, Virginia and West Virginia.

BUSINESS NOTES

W. E. MOORE & CO., Pittsburgh, Penn., is designing a new carbide plant which will involve the development of a water power of 3700 hp., utilizing a 46-ft. fall of the Saranac River. G. A. Stromblad is president of W. E. Moore & Company.

THE WISCONSIN BRIDGE & IRON CO., North Milwaukee, Wis., has engaged E. P. Rankin, Jr., as representative in the Southwest, with headquarters at El Paso, Texas.

THE STANDARD ASPHALT & REFINING CO., Chicago, has made arrangements with the Insulite Products Co., Inc., of Portland, Ore., to act as its agent for the Pacific coast. The Insulite company was recently organized by F. B. Gilman, with offices in Spokane, Tacoma, Seattle, San Francisco and Los Angeles.

THE REDWOOD MANUFACTURERS' CO. has received the contract for $400,000 worth of "Remco" pipe by the Butte Water Co., Butte, Montana.

ALEXANDER C. BROWN, president of the Brown Hoisting Machinery Co., Cleveland, has been elected president of the Northeastern Ohio division of the National Safety Council.

W. D. WARD has been transferred from the San Francisco office of the Pelton Water Wheel Co. to its New York office, where he will have the title of manager of the Atlantic department, which includes the territory east of the Mississippi, Europe and South America. Mr. Ward has been with the Pelton company for 25 years, and of late has held the position of contract and sales engineer. In New York he succeeds F. W. Gay.

TRADE PUBLICATIONS

The following companies have issued trade publications:

THE J. G. WHITE ENGINEERING CORPORATION, New York City, booklet 8 x 11 in., 24 pages, illustrated, describing "Nitrate Plant No. 1," on which the White Corporation performed the engineering and construction work.

THE WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J., bulletin 112-B, 8 x 10½ in., 36 pages, illustrated, describing condensers, pumps and cooling towers.

THE BALL ENGINE CO., Erie, Penn., pamphlet, 8½ x 11 in., illustrated, entitled "Loading Rock With the Erie Shovel."

THE BUCYRUS CO., South Milwaukee, Wis., bulletins G-1002, G-91, G-141, G-351, G-201, G-141 and G-1751, 8½ x 11 in., eight pages each. They describe various types of "Bucyrus" equipment, including trench excavators, revolving shovels and dragline excavators.

THE ROBBINS ENGINEERING CO., Chicago, Ill.; booklet, 8 x 10½ in., 16 pages, illustrated; shows various forms of portable conveyors and stackers for warehouse and industrial purposes and for loading railway cars.

THE BACHARACH INDUSTRIAL INSTRUMENT CO., Pittsburgh, catalog F and pamphlet P, 6 x 9 in., four pages, illustrated, describing pressure volume indicators and Pitot tubes and orifices for measuring the flow of gases.

THE AMERICAN STEAM CONVEYOR CORPORATION, Chicago, pamphlet 4 x 6¼ in., entitled "A Yard of Installations," showing equipment installed by the company in various buildings and industrial plants.

THE WARREN & IRRGANG CO., Springfield, Mass., bulletins numbers 19-1 to 19-4, 8½ x 11 in., illustrated, describing various types of hand trucks for industrial plants.

N. B. PAYNE & CO., New York City, bulletin No. 1, 9 x 11 in., illustrated, 16 pages, showing various types of cargo cranes.

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